GEOTECHNICAL ENGINEERING DESIGN GUIDE NO. 8

MECHANICALLY STABILIZED EARTH WALL (MSEW) DESIGN GUIDE

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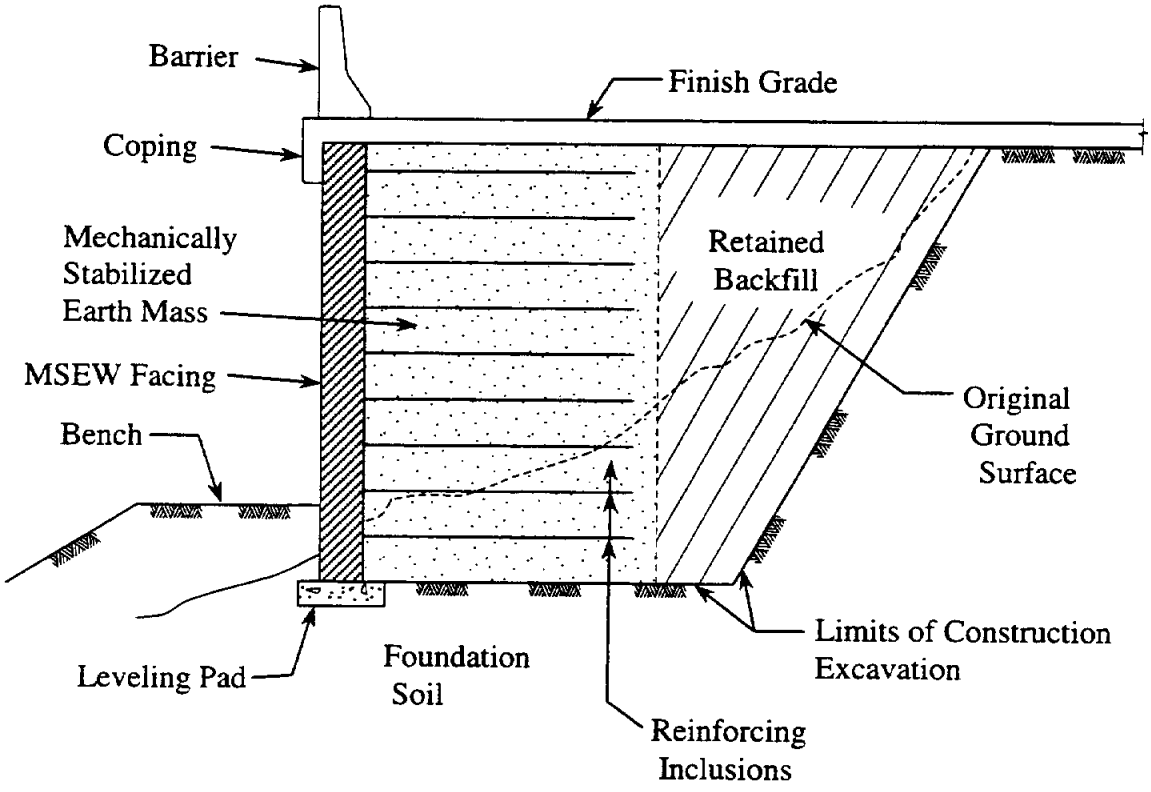

Mechanically Stabilized Earth Mass - Principal Elements

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MECHANICALLY STABILIZED EARTH WALL (MSEW) DESIGN GUIDE

8.01 INTRODUCTION

8.01.01 General: This document has been developed to facilitate the inclusion of Mechanically Stabilized Earth Walls (MSEW) into LA DOTD construction projects. This document provides guidance to the Department's engineers, consultants, and MSEW system suppliers on the feasibility, contracting methods, plan preparation, design, construction specifications, and review/approval of working (shop) drawings of MSEW structures.

8.01.02 MSE Wall Description: Mechanically Stabilized Earth Wall is a generic term that describes several soil retaining systems that consist of multiple layers of inclusions that act as reinforcements in soils. The reinforcements are those inclusions where the soil-reinforcement stress transfer occurs continuously. MSEW reinforcements have generally been steel strips, geotextile sheets, and steel or polymeric grids. The MSEW structures are built with facings to prevent the soil from raveling out between the rows of reinforcement. Common facings include precast concrete panels, modular concrete blocks, metal sheets and plates, gabions, welded wire mesh, shotcrete, and wrapped sheets of geosynthetics. The reinforced backfill has generally been a select granular backfill. The components of a typical MSEW retaining structure are shown in Figure 1.

8.02 MSEW SELECTION

8.02.01 General: When a retaining wall is required on a project, a team approach between the Pavement and Geotechnical Design Section and the Coordinating Section (Bridge or Road Design) should be used in the evaluation/decision-making process for selecting the proper type of retaining wall structure. The evaluation process should begin during the pre-design stage of plan development and completed after plan-in-hand. An informative and valuable reference for selecting the most suitable and cost effective retaining wall system is FHWA-SA-96-038, *"Geotechnical Engineering Circular No. 2 (Earth Retaining Systems)".*

Due to the numerous types of MSEW structures available, the Department will evaluate each approved MSEW system's design life, wall constructability, wall geometry, lateral wall displacement, site conditions, geotechnical concerns, and esthetics with respect to the project requirements. A list of appropriate MSEW systems will be developed upon completion of this evaluation.

8.03 MSEW DESIGN CONSIDERATIONS AND REQUIREMENTS

8.03.01 **Design Life:** MSEW structures are specified in the plans as either permanent or temporary structures based on their design life requirements.

1. **Permanent MSEW:** Permanent MSEW structures are generally designed for a 75-year design life. Permanent MSEW structures that support bridge abutments (without deep foundation support) should be designed for a 100-year design life.

2. **Temporary MSEW:** Temporary MSEW structures shall have a design life of not less than the contract time of the project or three years, whichever is greater. Structures remaining in service for more than 5 years shall be designed as permanent MSEW structures.

8.03.02 **Wall Constructability:** Construction of MSEW structures is relatively rapid and does not require specialized labor or equipment. Limited foundation preparation is generally required. An unreinforced concrete leveling pad is constructed to assist with position and alignment of the MSEW facing. Inspection activities generally consist of (1) monitoring tolerances and alignments to ensure proper fit and performance; and (2) monitoring compaction of backfill and placement of MSEW reinforcement. The interaction between the MSEW reinforcement and the backfill material requires that a select backfill be specified to ensure consistent design parameters. MSEW systems may not be feasible for grading conditions that require a side slope excavation cut. The additional costs associated with constructing a temporary retaining system to accommodate the reinforcement inclusions may make the construction of MSEW structures difficult and/or uneconomical.

8.03.03 **Wall Geometry:** The terminology for MSEW geometry is defined in Figure 2. MSEW structures can theoretically be designed for any height, H. MSEW height, H, is measured vertically from the top of the MSEW to the top of the leveling pad. External stability requirements may limit MSEW heights due to bearing capacity, settlement, or stability problems. Based on current experience in Louisiana, MSEW structures with panel type facings should not exceed heights of 12 meters (40 feet) and MSEW structures with modular block facings should not exceed heights of 9 meters (30 feet). Wall heights in excess of these limits will require approval from the Pavement and Geotechnical Design Section. The top of the leveling pad will require a minimum embedment below natural ground of 0.5 m (1.5 ft). Greater MSEW embedment depths may be required due to bearing capacity, settlement, stability, erosion, or scour requirements. Minimum embedment depths based on local bearing capacity considerations are shown in Table 1.

Table 1- Minimum MSEW Embedment Depth Based on Local Bearing Capacity

Slope in Front of Wall	Minimum Embedment Depth*
Horizontal (walls)	H/20
Horizontal (abutments)	H/10
3H:1V	H/10
2H:1V	H/7
1.5H:1V	H/5

* **Note:** Where H is the MSEW height. Minimum embedment depth should not be less than 500 mm (1.5 feet).

A minimum horizontal bench of 1200 mm (4 feet) will be required in front of the MSEW structure. The base width of MSEW structures typically extend back from the front of the wall facing a distance of 1.5 m (5 feet) to 3 m (10 feet) or 0.7H, whichever is greater (H is the MSEW height). MSEW structures with sloping surcharge fills or other concentrated loads will generally require longer reinforcement lengths of 0.8H to 1.1H.

When MSEW structures require a temporary barrier that is not restrained from sliding, the width of the MSEW structure shall be sufficient to allow placement of the outside edge of the barrier (double-face) a minimum distance of 600 mm (2 feet) from the wall face. Single-face temporary barriers will not be allowed, unless a clear distance of 1.5 m (5 feet) or greater is provided between the outside edge of the barrier and the face of the wall.

8.03.04 Lateral Wall Displacement: MSEW structures may experience lateral displacements during construction that may affect the MSEW performance. These lateral displacements are a function of overall structure stiffness, compaction intensity, soil type, reinforcement length, slack in reinforcement-to-facing connections, and deformability of the facing system. The MSEW system supplier is responsible for determining the construction batter that is required to meet the geometry requirements shown in the plans. Estimates of lateral wall displacements occurring during construction may be necessary during plan preparation to determine minimum clearances between the wall face and adjacent structures. Based on a reinforcement embedment ratio of 0.7H, the following equations may be used to make a rough estimate of probable lateral displacement, δ_{est}.

Inextensible Reinforcement:

$$\delta_{est} = \frac{H}{250}$$

Extensible Reinforcement:

$$\delta_{est} = \frac{H}{75}$$

The estimated lateral displacement, δ_{est}, will be in the same units as the units of the wall height, H. A wall height of 6 m (20 feet) will have an estimated lateral displacement, δ_{est}, of 24 mm (1.0 inch) for MSEW structures with inextensible reinforcement and 80 mm (3.2 inches) for MSEW structures with extensible reinforcement. Estimated lateral wall displacements, δ_{est}, for other reinforcement embedment ratios may be estimated using AASHTO 5.8.10.

8.03.05 Site Conditions: Current and future site conditions should be studied in detail. Future bridge and roadway widening projects should be considered in the design. Walls should be designed for any future wall heights and/or wall loads anticipated. Drainage systems to collect and divert water from the reinforced soil mass will be required when MSEW structures are constructed on a hillside or where other sources of water intrusion are possible. MSEW systems may not be appropriate for applications where:

(a) Environmentally aggressive conditions would degrade the MSEW components. Environmentally aggressive conditions are those which exceed the soil property requirements specified for the reinforced backfill material in GEDG subsection 8.09.01.

(b) Future access to underground utilities may be required.

(c) The potential for scour would undermine the stability of the wall.

(d) A significant horizontal curvature is required.

8.03.06 Geotechnical Concerns: Geotechnical concerns such as external stability and consolidation settlement may alter the MSEW selection or require special geotechnical construction techniques. External stability problems due to deep seated global stability, sliding of the reinforced soil mass, or bearing capacity may require excavation of unacceptable soils, stage construction, increased MSEW embedment depth, use of geosynthetic soil reinforcements, extension of minimum internal reinforcement lengths, or reductions in MSEW structure heights.

Long-term differential settlements perpendicular to the MSEW facing and along the MSEW facing should not exceed the limiting differential settlement tolerances specific to the MSEW system. Long-term differential settlements shall be computed in accordance with GEDG subsection 8.09.05. The MSEW system's limiting long-term differential requirements will be provided by the MSEW system supplier.

Differential settlements perpendicular to the MSEW facing (along the soil reinforcement) may occur at roadway widening projects. If this type of differential settlement exceeds a ratio of 1/10, the MSEW suppliers shall be consulted to determine if further analyses are required.

The values shown in Table 2 may be used as typical limiting differential settlement tolerances along the MSEW facing for MSEW structures with precast panel facings.

Table 2 - Limiting Differential Settlement for MSEW systems with Precast Concrete Panel Facing

Panel Joint Width	Limiting Differential Settlement
20 mm (3/4") *	1/100
13 mm (1/2") *	1/200
6 mm (1/8") *	1/300
Full Height Panel	1/500

* **Note:** Relatively square facing panels

MSEW structures with modular concrete block facings are typically restricted to a limiting differential settlement of 1/200 along the MSEW structure. Temporary MSEW structures with welded wire mesh facing should be restricted to a limiting differential settlement along the MSEW facing of 1/50.

Slip joints may be used to maintain MSEW structures within acceptable differential settlement tolerances. When significant differential settlements are anticipated, ground improvement techniques such as surcharges and wick drains may be required to accelerate the consolidation settlement. Walls shall be designed for any temporary surcharge loading. When long-term settlements are accelerated during construction, temporary wall facings may be required during this accelerated settlement phase followed by installation of permanent facings after the required level of settlement is achieved.

8.03.07 Aesthetics: Permanent MSEW facings shall be aesthetically pleasing. In some cases wall facing colors or designs could be specified with an added cost to the project. The LA DOTD standard MSEW facing appearance for panel facings is a gray painted finish, and for modular concrete block is a sandstone color. Aesthetic problems due to vandalism will be the same as with any retaining wall. Replacement of damaged facing blocks or panels that require friction connections between adjacent facing units would require that facing units above the damaged unit be removed.

8.04 MSEW CONTRACTING METHODS

8.04.01 General: Due to the numerous types of MSEW systems available, the Department has established an approval procedure for pre-qualifying MSEW systems. Approved MSEW systems can then be used for inclusion in LA DOTD construction projects. MSEW structures can be placed in the plans as the only design option or as an alternate to other types of retaining walls. The type and method of contracting MSEW systems shall be determined after the proposed MSEW structure is evaluated in accordance with GEDG sections 8.02 and 8.03 during the 60% Final Plans review. The evaluation process should consider the MSEW structure's design complexity, design life, construction method, quantity, height, load bearing application, location, aesthetics, etc.

8.04.02 Pre-Qualified System Based Contracting Method: The Pre-qualified System Based contracting method should be used for routine uncomplicated MSEW applications. This method of contracting MSEW systems consists of supplying a set of MSEW Control Plans and standard MSEW system plans in the contract documents. The contractor then selects from one of the approved MSEW system suppliers shown in the plans. During the bid process, the contractor specifies which MSEW system will be used. After the contract has been awarded, the contractor furnishes the Department a full set of working drawings and design calculations for approval. The Department's review/approval of the working drawings and supporting documentation is then coordinated by the project coordinator (Bridge Design or Road Design) with the support of the Pavement & Geotechnical Design Section.

8.04.03 Pre-Designed System Based Contracting Method: The Pre-Designed System-Based contracting method should be used for complex MSEW applications. This method of contracting MSEW systems requires that the MSEW system supplier submit design calculations and fully detailed design plans prior to taking bids. The approved final MSEW design plans are then included with the bid documents. These projects will require soliciting designs from MSEW system suppliers that are on the approved list of MSEW system suppliers whose MSEW system meets the project's design requirements. This contracting method would be used if the MSEW systems

exceed 12 m (40 feet) in height, exhibit some unusual geometric (i.e. acute angles of less than 70°, etc.), environmental, or topographic feature. MSEW design specifications may require modification to allow for special design requirements. The Department's review of the final MSEW design drawings and supporting documentation will be coordinated by the project coordinator (Bridge Design or Road Design) with support from the Pavement & Geotechnical Design section.

8.04.04 Temporary MSEW Contracting Method: The Temporary MSEW contracting method will be used when a temporary MSEW structure is required. Temporary MSEW structures may be specified solely or as an alternate to other temporary retaining wall systems such as steel sheet pile walls. All specific design requirements such as live loads, surcharge heights, and time requirements, and other design details should be specified in the plans or in the contract documents. Temporary MSEW structures will not be required to be on the approved MSEW system suppliers list. The contractor will be required to furnish the Department with a full set of working drawings and supporting documentation for review and approval. The Department's review of the working drawings and supporting documentation should be coordinated by the project coordinator (Bridge Design or Road Design) with support from the Pavement & Geotechnical Design Section.

8.05 PAY ITEMS OF MSEW STRUCTURES

8.05.01 General: Measurement and payment of MSEW structures is generally associated with the following MSEW construction procedures.

- **(a)** Excavation of the existing ground to the specified MSEW embedment depth and excavation of the existing ground behind the wall facing to facilitate construction of the reinforced backfill.
- **(b)** Installation of any MSEW drainage features required.
- **(c)** Placement of MSEW components and reinforced backfill. MSEW components include facing units, soil reinforcement, facing/soil reinforcement connection hardware, and any finishing details at the top of the wall (i.e. cap blocks, coping).
- **(d)** Placement and compaction of regular embankment material adjacent to the reinforced backfill.
- **(e)** Construction of traffic barriers (with moment slab and coping), noise walls, etc. above the MSEW structure.

In order to facilitate the measurement and payment of the MSEW structure, the following basic concepts have been adopted:

(a) The excavation and reinforced backfill quantity below the original ground line is paid for lump sum under S-Item, MSEW Structural Excavation and Backfill.

(b) The reinforced backfill and retained backfill quantity above original ground line is included in and paid for as regular embankment material under Item 203(04), Embankment.

(c) The MSEW components are paid for per square meter (square foot) of MSEW facing under S-Item, Mechanically Stabilized Earth Wall (MSEW). Included under the MSEW item is the cost difference between furnishing and placing the reinforced backfill and the regular embankment.

(d) Any traffic barriers, noise walls, etc. are paid for under the appropriate items.

8.05.02 Measurement and Payment: The measurement and payment of MSEW structures is based on separating the construction cost using the following pay items.

1. **S-Item, MSEW Structural Excavation And Backfill:** This item includes structural excavating, disposing, dewatering, and backfilling of materials below the original ground line to facilitate placement of the reinforced backfill. The plans should show an estimated excavation/backfill quantity for informational purposes. This estimated excavation/backfill quantity shall be based on the MSEW limits imposed by the minimum base width required, B_{Req}, shown in the plans. This item also includes furnishing and removing any temporary retaining systems deemed necessary by the contractor to install the MSEW structure. This item will be paid for Lump Sum.

2. **S-item, Mechanically Stabilized Earth Wall (MSEW):** This item consists of furnishing and constructing a permanent MSEW structure with precast concrete panel or modular concrete block facings. This item will include MSEW components consisting of leveling pad, facing units, soil reinforcement, facing/soil reinforcement connection devices, MSEW internal drainage features (if shown in the plans), and any finishing details at the top of the wall (i.e. concrete copings or cap blocks). The cost of furnishing and constructing the reinforced backfill above the regular embankment operations (203(04)) cost shall be included in this item. This item will be paid for per square meter (square foot) of vertical facing projected horizontally from the MSEW structure. The facing will be measured vertically from the top of the leveling pad to the top of the top of the MSEW structure.

Two types of S-items are available depending on the type of contracting method. If the Pre-Qualified System Based Contracting Method is used then this item will include the design and construction shop drawings as part of the item. No design or construction working drawings will be required if a Pre-Designed System Based Contracting Method is used.

3. **S-Item, Temporary Mechanically Stabilized Earth Wall (MSEW):** This item consists of designing, furnishing, and constructing a temporary MSEW structure with a welded wire facing. This item will include temporary MSEW components consisting of soil reinforcement, welded wire facing, reinforcement connection devices, geotextile fabric, and temporary facing aggregate. The cost of furnishing and constructing the reinforced backfill above the regular embankment operations (203(04)) cost shall be included in this item. The cost of structural excavating, disposing, dewatering, and backfilling of materials below the original ground line to facilitate placement of the reinforced backfill will also be included under this item. This item also includes furnishing and removing any temporary retaining systems deemed necessary by the contractor to install the MSEW structure. This item will be paid for Lump Sum.

4. **Item 203(04) Embankment:** This item consists of embankment construction throughout the project. The plan quantity includes the MSEW reinforced backfill area above the original ground line. The added cost of furnishing the select reinforced backfill and constructing the MSEW structure shall be included in the S-Item, Mechanically Stabilized Earth Wall (MSEW).

8.05.03 **Pay Item Format:** The S-Item, Mechanically Stabilized Earth Wall (MSEW) may apply to several approved MSEW systems. Since the Department will specify in the plans which MSEW systems can be used, the plans shall provide alternates to this S-Item for the contractors to bid. This can be done by denoting every MSEW item with the name of the approved MSEW system that the contractor may bid as follows:

S-Item (A, B, ...), Mechanically Stabilized Earth Wall (MSEW)
(MSEW System Name/Supplier)

The contractor will be required to place his bid to select one of the MSEW system alternates. After the contract is awarded, the contractor will be required to build the MSEW structure that was selected in the contractor's bid.

8.06 MSEW SPECIAL DETAILS

8.06.01 General: Special details and designs are required for the development of a complete and informative set of MSEW Control Plans. Most of these details are needed because of the interconnectivity between the MSEW structure and the adjoining structures such as roadway, bridge, utilities, and drainage structures. Additional details may be required to accommodate construction phasing and/or specialized geotechnical construction techniques. Specialized geotechnical construction techniques arise when construction procedures are specified to control settlement and external stability problems. Details for permanent MSEW systems with modular concrete block facings (MSEBW) and MSEW systems with precast concrete panel facings (MSEPW) will be addressed in this document. The details presented below may not be appropriate for all projects due to the numerous design configurations and types of MSEW systems available. In these cases, the details should be modified to fit each specific project.

8.06.02 Abutment Details: Special details and designs are required when MSEW structures are placed at abutments. MSEW termination details beyond the end of the abutments (under the bridge) will depend on the proximity of any obstructions and the bridge structure's horizontal and vertical clearance. Typical generic details for both MSEBW and MSEPW are shown in Figure 3-A for bridge abutments terminating with end slopes and in Figure 3-B for bridge abutments terminating with vertical (or semi-vertical) wall facings.

8.06.03 Barrier Details: Special details and designs are required when MSEW structures require barriers on top of the walls. Typical generic cast-in-place barrier details for permanent MSEW structures with modular concrete blocks or precast concrete panel facings are shown in Figure 4. Typical generic precast barrier details for permanent MSEW structures with precast concrete panels are shown in Figure 5. When MSEW structures require a temporary barrier (single or double-faced) that is not restrained from sliding, the temporary barrier shall be placed as shown in Figure 6. When permanent barriers are placed directly over MSEW structures, a barrier coping will be required along the top of the MSEW structure to conceal the interface between the barrier slab and the top of the MSEW structure. Typical generic barrier coping details for permanent MSEW structures are shown in Figure 7.

8.06.04 **MSEW Embedment Details:** Special details are required to show typical MSEW leveling pads and minimum MSEW embedment below natural ground. Typical generic details for permanent MSEW structures are shown in Figure 8.

8.06.05 **MSEW Facing Details:** Special details are required to show typical MSEW precast concrete panel facings and modular concrete block facings. Typical generic facing details for permanent MSEW structures are shown in Figure 9.

8.06.06 **Temporary Facings:** Special details and designs are required when temporary facings are required for MSEW structures. Typical generic temporary facing details for MSEW structures are shown in Figure 10.

8.06.07 **Paved Ditch Details:** Special details and designs are required when MSEW structures require a paved ditch at the top of the wall to control water runoff from the roadway. Typical generic paved ditch details for permanent MSEW structures are shown in Figure 11. Additional details may be required to show the ditch bottom grade transition when the top of the walls are stepped. Paved ditches will require a separate pay item from the MSEW pay item. Concrete copings along the top of the MSEW that are connected to a paved ditch are paid under the MSEW item.

8.06.08 **MSEW Internal Drainage Details:** Special details and designs are required when MSEW internal drainage is required to intercept groundwater from intruding into the reinforced backfill of a MSEW structure. Typical generic drainage details for permanent MSEW structures are shown in Figures 12 and 13.

8.06.09 **Obstructions:** Special details and designs are required when obstructions such as abutment piling, drainage pipes, junctions with cast-in-place structures, back-to-back MSEW, etc. interfere with the MSEW structure. Typical generic details for obstructions in permanent and temporary MSEW structures are shown in Figures 14 through 19.

8.06.10 **Geotechnical Details:** Special details and designs are required when geotechnical requirements, such as stage construction of the MSEW facings, embankment surcharges, wick drains, and settlement monitoring of an MSEW structure are required. Typical generic geotechnical details for MSEW structures are shown in Figures 20 through 23.

8.07 MSEW PLAN PREPARATION

8.07.01 General: Plan preparation will depend on the selected method of MSEW contracting. The primary plan development effort shall be the MSEW Control Plans. The MSEW Control Plans will specify horizontal and vertical control of the MSEW structure. It will also detail any specific wall design requirements such as wall face batter, live and dead loads, drainage features, soil borings, design requirements, etc. The success of the following contracting methods is highly dependent on complete, accurate, and informative MSEW Control Plans.

8.07.02 Pre-Qualified System Based Contracting Method: The procedures for developing projects with MSEW structures shall be as follows.

1. **60% Final Plans:** The preliminary plans submitted for review at 60% final plans shall have sufficient detail to define horizontal and vertical control of the MSEW structure on the plan and profile sheets and cross-sections. Plan and profile sheets shall include as minimum items 1 through 11 of heading "A" below. Soil borings and cross-sections shall also be included with the preliminary plans. Pay items and quantities will not be required for the preliminary plans submitted for review at 60% final plans. During the 60% final plan review, the Pavement and Geotechnical Design Section will perform a settlement analysis and an external stability analysis of the MSEW structure based on GEDG subsections 8.09.05 and 8.09.06. These geotechnical analyses shall be used to establish criteria for the selection, design, and construction of the MSEW structure.

   A preliminary set of MSEW Control Plans shall then be developed based on the comments received from the 60% final plan review. After completion of the preliminary MSEW Control Plans, two copies of the plans will be sent to the Pavement and Geotechnical Design section for review and approval. The project design coordinator (Bridge or Road Design) will then send a notification letter to each of the pre-selected MSEW system suppliers on the approved MSEW system list. The notification letter will indicate the preliminary MSEW design criteria. Transmitted along with the notification letter will be one copy of the approved preliminary MSEW Control Plans and one copy of the project plans (roadway and/or bridge plans). An example of a notification letter is shown in Appendix B-1. This information shall be used by the

MSEW system supplier in preparing bid estimates and in providing an opportunity for feedback on innovative methods or designs for the project. Any feedback from the MSEW system supplier shall be submitted, evaluated, and modified as needed prior to 95% final plans (ACP).

The preliminary set of MSEW Control Plans shall include the following information:

A. Plan and Profile Sheet:

(1) Plan view of wall

(2) Horizontal and vertical alignment

(3) Wall limits including beginning and ending stations along project centerline and MSEW base line. A continuous MSEW base line should be placed along the wall face from the beginning to the end of the MSEW structure.

(4) Elevation view of the wall along the MSEW base line showing top of wall, maximum elevation at top of leveling pad, existing ground lines, and proposed ground lines.

(5) Table showing top of wall and maximum elevation at top of leveling pad (minimum wall embedment) at maximum intervals of 10 m (30 feet) along the MSEW base line

(6) Soil boring locations

(7) Location and elevation of all utilities, signs, etc., and the loads imposed by each such appurtenance.

(8) Mean high water, design high water level, flood stage, and drawdown conditions where applicable.

(9) Typical cross-section that indicates maximum face batter allowed, horizontal alignment control (top or bottom of wall), pay limits, backfill drainage requirements, offset control, excavation limits, ditches, sidewalks, superelevations, and other unusual features.

(10) Construction constraints such as phased construction sequence, right-of-way, construction easements, etc.

(11) Wall quantity (pay area of walls)

(12) Table indicating MSEW minimum base width required (B_{Req}) or ratio of minimum base width required to MSEW height (B_{Req}/H) if required for external stability

(13) General notes

(14) In-situ soil characteristics (ultimate bearing capacity, predicted settlement, etc.)

(15) Design parameters (safety factors)

B. Soil Borings

C. General MSEW Details showing

(1) Wall/end bent cap interface
(2) Barrier and coping to wall interface
(3) Pile, inlets and pipe conflicts with soil reinforcement
(4) Slip joint details

D. Pre-Approved Standard MSEW Drawings: Standard drawings of each of the pre-selected MSEW system suppliers shall be included in the preliminary Control Plans. These standard drawings can be obtained from the Bridge Design section.

3. **95% Final Plans (Advanced Check Prints):** Final MSEW Control Plans shall be prepared based on any MSEW system supplier's comments prior to finalizing Advanced Check Prints (ACP). ACP plans shall include pay items and MSEW quantities.

3. **98% Final Plans:** Any modification to the plans because of comments received after the 95% Final Plans (ACP review) will be made at this time. The final construction specifications will then be prepared. Any modifications required to the standard MSEW construction specifications due to project specific requirements shall be made at this time.

8.07.03 Pre-Designed System Based Contracting Method: The procedures for developing projects with MSEW structures shall be as follows.

1. **60% Final Plans:** The preliminary plans submitted for review at 60% final plans shall have sufficient detail to define horizontal and vertical control of the MSEW structure on the plan and profile sheets and cross-sections. Plan and profile sheets shall include as minimum items 1 through 11 of heading "A" below. Soil borings and cross-sections shall also be included with the preliminary plans. Pay items and quantities will not be required for the preliminary plans submitted for review at 60% final plans. During the 60% final plan review, the Pavement and Geotechnical Design Section will perform a settlement analysis and an external stability analysis of the MSEW structure based on GEDG subsections 8.09.05 and 8.09.06. These geotechnical analyses shall be used to establish criteria for the selection, design, and construction of the MSEW structure.

   A preliminary set of MSEW Control Plans shall then be developed based on the comments received from the 60% final plan review. After completion of the preliminary MSEW Control Plans, two copies of the plans will be sent to the Pavement and Geotechnical Design Section for review and approval. The project design coordinator (Bridge or Road Design) will then send an

invitation letter to each of the pre-selected MSEW system suppliers that are on the approved MSEW system list. The invitation letter will indicate the preliminary MSEW design criteria. Transmitted along with the notification letter will be one copy of the approved preliminary MSEW Control Plans and one copy of the project plans (roadway and/or bridge plans). The MSEW system supplier shall notify the Department in writing their intent to participate in the project. If the MSEW system supplier chooses to participate, they shall provide four sets of MSEW design plans and calculations for review as indicated in the invitation letter. An example of an invitation letter is shown in Appendix B-3. All plans and calculations shall bear the legible seal, date, and signature of the responsible Professional Civil Engineer registered in the State of Louisiana with the following Statement: ***"Certified with respect to structural adequacy and stability in accordance with LA DOTD requirements and procedures"***. The Pavement and Geotechnical Design Section shall review the design and approve, reject, or return the design to the MSEW system supplier for modifications and resubmittal.

2. **95% Final Plans (Advanced Check Prints):** Final MSEW Control Plans shall be prepared based on MSEW system supplier's comments and the approved MSEW design plans prior to finalizing Advanced Check Prints (ACP). ACP plans shall include pay items and MSEW quantities.

3. **98% Final Plans:** Any modifications to the plans because of comments received after the 95% Final Plans (ACP review) will be made at this time. The final constructions specifications will then be prepared. Any modifications required to the standard MSEW construction specifications due to project specific requirements will be made at this time.

8.07.04 Temporary MSEW Contracting Method: During the preliminary plan development phase, the Project Coordinator will determine if a temporary MSEW structure will be required or if it will be used as an alternate to a sheet pile or other type of temporary retaining wall system. The following information will be shown in the plans if a temporary MSEW structure will be allowed during construction.

A. Plan and Profile Sheet:

(1) Plan view of wall indicating beginning and ending limits.
(2) Horizontal and vertical alignment
(3) Table showing top of wall and maximum elevation at top of leveling pad (minimum wall embedment) at maximum intervals of 10 m (30 feet) along the MSEW base line
(4) Soil boring locations
(5) Location and elevation of temporary barriers, utilities, signs, etc., and the loads imposed by each such appurtenance.
(6) Mean high water, design high water level, flood stage, and drawdown conditions where applicable.
(7) Construction constraints such as phased construction sequence, right-of-way, construction easements, etc.
(8) Wall quantity (for informational purpose)
(9) Table indicating MSEW minimum base width required (B_{Req}) or ratio of minimum base width required to MSEW height (B_{Req}/H) if required for external stability
(10) General notes
(11) In-situ soil characteristics (ultimate bearing capacity, predicted settlement, etc.)
(12) Design parameters (safety factors)

B. Soil Borings

C. MSEW Details showing

(1) Temporary wall facing
(2) Temporary barrier
(3) Conflicts or obstruction between the temporary MSEW structure and piles, drainage structures, utilities, etc.

8.08 DESIGN SCOPE

8.08.01 General: The MSEW structures shall be considered gravity walls and shall be designed for external and internal stability of the reinforced soil mass. The design responsibilities of the Department and the MSEW system supplier are detailed below.

8.08.02 Department Design Responsibility: The Department shall be responsible for performing a settlement analysis and an external stability analysis of the MSEW structure in accordance with GEDG subsections 8.09.05 and 8.09.06. The settlement analysis will consist of determining the magnitude (total and differential ratio) and time rate. The external stability shall consist of analyzing global stability (deep-seated failures), sliding stability, overturning,

and bearing of the MSEW structure. The external stability will be checked initially using the minimum reinforcement length required. If additional reinforcement length is required, the plans will indicate the minimum base width required, B_{Req}, for external stability.

8.08.03 MSEW System Supplier Design Responsibility: The MSEW system supplier shall be responsible for the internal stability design of the MSEW structure in accordance with GEDG subsection 8.09.07. The Department shall provide the geotechnical design parameters required for analysis of the internal stability of the MSEW system. The MSEW system supplier's design shall consist of determining the required soil reinforcement length and strength, connection strength, and facing stability in accordance with the plans and specifications. The MSEW system supplier's design shall specify the minimum required wall face batter to limit the amount of horizontal movements resulting from the outward rotation of the wall as a result of the development of internal equilibrium between the loads applied to the wall and the internal structure of the wall.

8.08.04 MSEW Design Methodology: The design of the MSEW structure shall be in accordance with the Department's ***Geotechnical Engineering Design Guide No. 8 (GEDG No. 8)*** and the 1997 interim or more current AASHTO "Standard Specifications for Highway Bridges." Design criteria specified in GEDG No. 8 shall supercede AASHTO requirements. Designs based on methodology other than stated above shall not be accepted. The following references shall supplement the design methodology as required. The sequential order of these references shall dictate their superseding order.

(a) FHWA-SA-96-071, *"Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines"*

(b) FHWA-SA-96-072, *"CorrosionlDegradation of Soil Reinforcement for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines"*

(c) NCMA, 1997, second edition, *"Design Manual for Segmental Retaining Walls"*

(d) FHWA HI-95-038, *"Geosynthetic Design and Construction Guidelines"*

8.09 SPECIFIC DESIGN REQUIREMENTS

8.09.01 Reinforced Backfill Material: The reinforced backfill routinely specified will be a select granular backfill material. When drainage and/or site conditions warrant a free draining material, a select stone backfill will be used. The reinforced backfill limits shall extend from the MSEW facing element to 300 mm (1 foot) beyond the required reinforcement length. Design parameters

and material requirements for granular backfills, stone backfills, and block fill are shown below.

1. **Granular Backfill:** The reinforced backfill shall be a granular material with a design internal friction angle (ϕ) of 30 degrees. The reinforced backfill shall have a design wet unit weight of 18.1 kN/M^3 (115 pcf). The granular backfill material shall have the gradation shown in Table 3.

Table 3 - Reinforced Granular Backfill Gradation

Sieve Size	Percent Passing
19 mm (¾")	100
4750 µm (No. 4)	20 – 100
2000 µm (No. 10)	15 – 85
425 µm (No. 40)	10 – 35
150 µm (No. 100)	0 – 10
75 µm (No. 200)	0 - 5

2. **Stone Backfill:** The reinforced backfill shall be a crushed stone with a design internal friction angle (ϕ) of 34 degrees. The reinforced backfill shall have a design wet unit weight of 14.9 kN/m^3 (95 pcf). The stone backfill material shall have the gradation shown in Table 4.

Table 4 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
9.5 µm (⅜")	20 - 55
4750 µm (No. 4)	0 - 10
2360 µm (No. 8)	0 - 5

3. **Block Fill:** The block fill material shall be crushed stone or gravel with a minimum of 75% crushed material retained on a 4750 µm (No. 4) sieve size and shall have the gradation shown in Table 5.

Table 5 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
2360 µm (No. 8)	0 - 10
300 µm (No. 50)	0 - 5

4. **Soil Property Requirements For Reinforced Backfill:** All reinforced backfill material shall have the following soil properties:
   (a) pH values shall range between 4.5 and 9.0 (TR 430).
   (b) Organic content shall not exceed 0.5 percent (weight of organic material to weight of total sample as determined by TR 413).

   MSEW systems with steel reinforcement shall have the following electrochemical properties:
   (a) The resistivity shall be greater than 3000 ohm-cm DOTD TR 429.
   (b) The chloride content shall be less than 100 ppm AASHTO T-291.
   (c) The sulfate content shall be less than 200 ppm AASHTO T-290.

8.09.02 Retained Backfill Material: The retained backfill is composed of either newly placed embankment materials or existing soils. The geotechnical engineer will evaluate the anticipated retained backfill material that may be used and select appropriate design parameters. The following soil design parameters may be used for new embankment.

(a) Granular or low plasticity (PI<30) material:
- Undrained shear strength (short-term): Cohesion of 12.0 kPa (250 psf) and internal soil friction angle (Φ) of 17 degrees
- Drained shear strength (long-term): Internal soil friction angle (Φ) of 28 degrees
- Wet unit weight of 18.9kN/m^3(120 pcf)

(b) Cohesive material with high plasticity (30 ≤ PI < 45):
- Undrained shear strength (short-term): Cohesion of 24.0 kPa (500 psf)
- Drained shear strength (long-term): Internal soil friction angle (Φ) of 18 - 24 degrees
- Wet unit weight of 18.9 kN/M^3 (120 pcf)

When MSEW structures are constructed in cuts, soil properties obtained from laboratory testing shall be used.

8.09.03 Wall Loads: The MSEW structures shall be designed to resist hydrostatic loads, traffic loads, point loads, line loads, and surcharge loads in accordance with these specifications.

1. **Hydrostatic Loads:** MSEW structures shall be designed to resist hydrostatic loads when applicable. Effective unit weights shall be used below the design hydrostatic levels for external and internal stability design computations. When MSEW structures are subject to rapid drawdown conditions, the maximum differential hydrostatic pressure shall be used as shown in the control plans.

2. **Permanent Point, Line, and Uniform Loads:** The effects of permanent point, line, and uniform loads shall be used in developing the design earth pressures. Load shall be distributed in accordance with Figures 24, 25, and 26.

3. **Traffic Loads:** When traffic loads are applied over the internal or external active zones, the lateral earth pressure for design shall be computed using a 15 kPa (250 psf) uniformly distributed load. Live loads shall not be included when they act as resistance forces.

4. **Parapet and Barrier Loads:** When parapets or barriers are located in line with the front face of the MSEW, the parapets or barriers shall be designed to resist overturning moments by their own mass.

8.09.04 Obstructions: Construction of MSEW structures at pile supported abutments, drainage structures, and other miscellaneous structures often results in conflicts between the soil reinforcement and the structure in the reinforced backfill. Abutment piles are generally driven and cased prior to constructing the MSEW structure as shown in Figure 14. The reinforcement layout details and design shall be made so that the internal stability of the MSEW structure or its serviceability is not compromised. Overstressing of the surrounding reinforcement shall not be permitted. Connection of reinforcements to the bridge foundation shall not be permitted. The bridge abutment pile shall not be used to resist horizontal forces in MSEW internal stability computations. Soil reinforcement layout details at bridge abutment piles and other vertical obstruction shall be in accordance with layout details shown in Figure 15. Soil reinforcement layout details at drainage structures shall be in accordance with layout details shown in Figure 16. Soil reinforcements conflicting with horizontal obstructions shall be constructed in accordance with the layout details shown in Figure 17. Special details shown in Figure 18 shall be used for MSEW structures interfacing with cast-in-place wall structures. When soil reinforcement conflicts occur when back-to-back MSEW are constructed, the soil reinforcement shall be overlapped as shown in Figure 19.

8.09.05 Settlement: The magnitude and time rate of consolidation settlement shall be computed under MSEW structures founded over clay soils. Consolidation settlement shall be computed using one-dimensional consolidation theory in accordance with FHWA-HI-88-009(revised), *"Soils and Foundations Workshops Manual"*. Differential settlements shall be computed along the soil reinforcement and along the MSEW facing. The differential settlements shall not exceed the MSEW system supplier's limiting differential settlements as stated in subsection 8.03.06 of this document.

8.09.06 External Stability: The external stability of the MSEW structure (reinforced soil mass) shall be checked for global stability (deep-seated failures), sliding stability, overturning, and bearing as indicated in Figure 27-A. The external stability calculations shall be made from the top of the leveling pad. Unfactored dead and live loads shall be used to determine the factors of safety. The unit weight of the concrete modular block facing shall be assumed equal to the unit weight of the reinforced backfill. The passive earth pressure resistance in front of the wall shall be neglected. The MSEW structure's required base width, B_{Req}, or embedment depth, H, may be modified to meet the required safety factors for external stability. The geotechnical design parameters and safety factors required to perform the external stability calculations are provided below.

1. **Global Stability (Deep Seated):** A minimum safety factor of 1.3 for global stability, $\mathbf{SF_{Global}}$, shall be required. Global stability shall be checked for both circular and sliding block failure mechanisms.
2. **Sliding Stability:** A minimum safety factor of 1.5 for sliding stability shall be required. The factor of safety shall be checked for sliding of the reinforced soil mass along the foundation soil, reinforced backfill, and soil-reinforcement interface. Sliding resistance shall be computed using the following failure planes:
   - **(a) Foundation Soil:** Frictional resistance of the foundation soils should be computed for both undrained conditions (short-term) and drained conditions (long-term).
   - **(b) Reinforced Backfill:** Frictional resistance of the reinforced backfill should be computed using an internal angle of friction specified in subsection 8.09.01.
   - **(c) Soil-Reinforcement Interface:** The frictional resistance along strip or other non-sheet types of reinforcement shall be computed using the soil coefficient of friction ($\mu_{soil} = \tan \phi_{soil}$) of the reinforced backfill.

     The frictional resistance along sheet type reinforcement (geotextile or geogrid) shall be estimated as 2/3 of the reinforced backfill coefficient of friction, μ_{soil}. If direct shear laboratory tests documenting the coefficient of friction for site specific reinforced backfill material or representative soil is available during design, it may be used in lieu of the estimated coefficient of friction.

     If the factor of safety for sliding is governed by the sliding along the soil-reinforcement interface of sheet type reinforcement, separate base width requirements, B_{Req}, shall be specified for sheet type reinforcement.

3. **Overturning:** A minimum safety factor of 2.0 for overturning shall be required. The eccentricity of the bearing pressure resultant with respect to the center of the wall base shall be maintained within 1/6 of the reinforcement length, L.

4. **Bearing Capacity:** The bearing stress below the reinforced soil bearing zone (L-2e) of the MSEW structure shall not exceed the allowable bearing capacity. MSEW structures shall require a minimum safety factor of 2.5 for bearing capacity. Local shear shall also be checked to prevent lateral squeezing of soft foundation soil.

8.09.07 Internal Stability: Internal stability computations shall consist of designing against three modes of failure: soil reinforcement rupture, soil reinforcement pullout, and connection failure between the soil reinforcement and the facing. Rupture failure of the reinforcement and pullout failure of the reinforcement are shown in Figure 27-B. Internal stability calculations shall be made from the back of the wall facing elements. The wall height shall be defined as the vertical distance from the top of the leveling pad to the top of the wall where the soil finished grade or bottom of pavement (concrete or asphalt excluding base and subbase courses) intersects the back of the wall face.
The following design criteria shall be used:

1. **Critical Slip Surface:** The critical slip surface defines the boundary between the active zone and the resistant zone. The critical slip surface is assumed to be the location of maximum stress. The location of the critical slip surface will vary based on the type of soil reinforcement (extensible or inextensible) used in the MSEW system and if any superimposed loads are placed on the MSEW structure. The critical slip surface for MSEW structures without superimposed loads shall be assumed to begin at the back of the facing element at the top of the leveling pad and extend as follows.
   (a) **Extensible Reinforcement:** When MSEW with extensible reinforcements (geosynthetics) and a face batter of less than 10 degrees from the vertical is used, the critical slip surface shall be defined by the Rankine method ($45 + \frac{1}{2}\phi$). When a face batter of 10 degrees or greater is used, the critical slip surface shall be defined by the Coulomb method.
   (b) **Inextensible Reinforcement:** MSEW with inextensible reinforcements (steel strips or steel grids) shall use a bilinear surface as defined in the AASHTO specifications.

   The critical slip surface for MSEW structures with superimposed loads shall require a more rigorous analysis in accordance with FHWA-SA-96-071, *"Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines".*

2. **Maximum Reinforcement Load (T_{max}):** The maximum reinforcement tensile load, T_{max}, is the horizontal soil stress that results from a level backfill plus any lateral earth pressures from vertical or horizontal loads (i.e. sloping backslope, parapets, traffic barriers, surcharges, hydrostatic, etc...). The maximum reinforcement tensile load, T_{max}, shall be checked at every level within the wall for ultimate limit state. The maximum reinforcement loads for extensible or inextensible reinforcements shall be calculated using the Simplified Coherent Gravity method. The ratio of K_r/K_a for geosynthetic reinforcements (including geogrids) and for inextensible reinforcement such as metal strips, metal bar mats, and welded wire grids shall be determined using Figure 28. The T_{max} shall be computed on a load per unit length of wall basis.

3. **Reinforcement Tensile Load at the Connection to the Wall (T_o):** The tensile load applied to the soil reinforcement connection at the wall face, T_o, shall be equal to the maximum reinforcement tensile load, T_{max}, for all wall systems regardless of facing and reinforcing type. The T_o shall be computed on a load per unit length of wall basis.

4. **Design Life:** Permanent MSEW structures shall be designed for a 75 year design life or as specified in the plans. Permanent MSEW structures supporting bridge abutments (without deep foundation support) shall be designed for a 100 year design life or as specified in the plans. Temporary MSEW structures shall be designed for a minimum design life of 3 years. If temporary MSEW structures remain in service for more than 5 years, they shall be designed as permanent MSEW structures.

5. **Reinforcement Coverage Ratio, R_c:** The reinforcement coverage ratio, R_c, shall be defined as the unit width of discrete reinforcement, b, divided by the horizontal spacing of discrete reinforcement, S_H. Continuous reinforcement layers such as sheet type reinforcement (geogrid) shall have a reinforcement coverage ratio, R_c, equal to 1.0.
6. **Allowable Reinforcement Strength Design:** The allowable long-term tensile strength, T_a, multiplied by the reinforcement coverage ratio, R_c, shall be greater than or equal to the maximum reinforcement tensile load, T_{max}.

7. **Allowable Connection Strength Design:** The allowable wall connection load, T_{ac} multiplied by the reinforcement coverage ratio, R_c, shall be greater than or equal to the tensile load at the connection to the wall facing, T_o.

8. **Pullout Resistance Length Design:** At each reinforcement level, the maximum reinforcement tensile load, T_{max}, shall be computed to determine the effective pullout length, L_e, which extends beyond the critical slip surface. Vertical earth pressures, σ_v, shall not include traffic loads. The reinforcement effective unit perimeter, C, shall be a constant value of 2. The pullout resistance factor, F* and the scale effect correction factor, α, shall be certified as required in section 8.10.04. The minimum factor of safety against pullout, FS_{po}, for permanent and temporary MSEW shall be 1.5. The minimum length of soil reinforcement behind the zone of critical slip surface shall be 1 m (3 feet). The total reinforcement length required for pullout resistance shall be the pullout length required plus the distance from the wall connection to the critical slip surface.

8.09.08 MSEW Facing Design:

1. **Modular Concrete Block Facing Design:** The facing stability calculations shall include an evaluation of the maximum vertical spacing between reinforcement layers, the maximum allowable facing height above the uppermost reinforcement layer, inter-unit shear capacity, and resistance of the facing to bulging. The maximum vertical spacing between reinforcement layers shall be limited to twice the depth of the concrete block facing unit, W_u, (modular concrete block dimension perpendicular to the MSEW facing is defined as the depth, W_u) or 800 mm (31 inches), whichever is less. The maximum facing height above the uppermost reinforcement layer shall be limited to the depth of the facing block, W_u, unless system specific calculations, demonstrating stability at greater heights, have been submitted and accepted by the Department. The maximum depth of facing below the bottom reinforcement layer shall be limited to the depth of the facing block, W_u.

2. **Precast Panel Facing Design:** The facing shall be designed to resist horizontal loads from the maximum tensile reinforcement, T_{max}, and potential compaction stresses. The facing elements shall be stabilized such that they do not deflect laterally or bulge beyond the required tolerances. The facing elements shall be structurally designed in accordance with AASHTO 5.8.8.1

3. **Temporary Facing:** Temporary facings such as welded wire facing or geosynthetic facing shall be designed in a manner which prevents the occurrence of bulging in excess of 50 mm (2 inches) when backfill behind the facing elements is compressed due to compaction stresses or self weight of the backfill. When temporary facings (i.e. welded wire facing) are specified prior to constructing the permanent facing, bulging shall be less than 25 mm (1 inch). Bulging shall be measured from the theoretical vertical or sloped face of the temporary MSEW face.

8.09.09 Minimum Base Width Required, B_{Req}

1. **General:** The minimum base width requirement, B_{Req}, for MSEW with modular concrete block facings shall be measured from the front of the facing element to the end of the soil reinforcement. When MSEW with precast concrete panel facings are used, the MSEW base width required, B_{Req}, shall be measured from the back of the facing element to the end of the soil reinforcement.

2. **Minimum Base Width Required, B_{Req}:** The MSEW base width required shall be the larger of:
   (a) The minimum base width required, B_{Req}, for MSEW that are 3.0 m (10.0 ft.) or less are shown in Table 6.

Table 6, Minimum Base Width Required, B_{Req}, for MSEW heights of 3.0 m (10.0 ft.) or less.

MSEW Height Limits	Base Width
H<1.0 m (3.3 ft.)	No Soil Reinforcement Required
1.0 m (3.3 ft.) <= H <=1.5 m (5.0 ft.)	1.5 m (5.0 ft.)
1.5 m (5.0 ft.) < H < 3.0 m (10.0 ft.)	2.5 m (8.0 ft.)
H >= 3.0 m (10.0 ft.)	3.0 m (10.0 ft.)

   (b) As required for external stability

The minimum base width required, B_{Req}, for the MSEW structure will be shown in the plans in the form of a plan note or a table. The plans will indicate the MSEW locations (stations) and either the minimum base width requirement, B_{Req}, or the ratio of minimum base width required to wall height (B_{Req}/H). Specifying the MSEW base width required, B_{Req}, should be used primarily on walls with approximately uniform wall heights. When MSEW heights vary significantly as in bridge approaches, the ratio of MSEW base width required to MSEW height should be used.

8.09.10 Reinforcement Length, L: The soil reinforcement length, L, shall be measured from the back of the MSEW facing element. The soil reinforcement length shall be sufficiently long to meet the safety factors and design considerations for internal stability and the MSEW minimum base width required, B_{Req}. The reinforcement length shall be uniform throughout the entire height of the wall. The total reinforcement length, L_{total}, shown in the working drawings shall include any additional soil reinforcement required for facings or connections to the facings elements. The minimum reinforcement length, L, required from the back of the MSEW facing shall be the larger of:

(a) 70% of the wall height

(b) As required for internal stability calculations for pullout design 8.09.07(8)

(c) As required by the minimum base width required, B_{Req}, in subsection 8.09.09(2).

8.09.11 MSEW Reinforcement

1. **General:** Either extensible (geosynthetic) or inextensible soil reinforcement may be used. Soil reinforcements shall have sufficient allowable tensile strength and pullout resistance to resist the maximum reinforcement load, T_{max}.
2. **Extensible Reinforcement (Geosynthetics):**
   Extensible reinforcements such as geosynthetic reinforcements may be either geotextile fabrics or geogrids. Geosynthetic reinforcement design requirements shall be as shown in the plans or specified in the working drawings. Geosynthetic reinforcements will require a manufacturer's certification along with supporting documentation of design and field performance properties. Parameters for geosynthetic reinforcement strength calculations are defined in Figure 29. Geotextile fabric reinforcements shall be a woven geotextile consisting only of long chain polymeric filaments or yarns formed into a stable network. Geogrid reinforcements shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. The geogrid structure shall be dimensionally stable and be able to retain its geometry under construction stresses. Geosynthetic reinforcements shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced. The contractor shall certify the allowable strengths, pullout coefficients, and the allowable reinforcement/block

facing connection strength for the MSEW soil reinforcement prior to delivery of the MSEW components to the construction site. The Certification package requirements shall be as specified in GEDG sections 8.10.

If the parapet or barrier and pavement are not structurally tied together so that impact loads are transmitted to the pavement, the upper two rows of soil reinforcement shall be structurally sized to resist an additional horizontal load of 29 kN/linear meter of wall (2 kips/linear foot of wall). Due to the transient nature of the impact loads on barriers, when designing for reinforcement rupture, the geosynthetic reinforcement must be designed to resist the static and transient (impact) components of the load as follows:

Static Component:

$$T_{max} \leq \frac{S_{rs} \times R_c}{RF \times FS}$$

Transient Component:

$$\Delta\sigma_h S_v \leq \frac{S_{rt} \times R_c}{RF_{ID} \times RF_D \times FS}$$

These variables are defined as follows:

$\Delta\sigma_h$ = Horizontal stress, $\Delta\sigma_h$, due to traffic barrier impact. Horizontal stress applied over the reinforcement tributary area in accordance with Figure 25.

FS = The minimum factor of safety, FS, for permanent MSEW structures is 1.5. Temporary MSEW structures shall have a FS of 1.2.

R_c = Soil reinforcement coverage ratio

RF = Total reduction factor

RF_{ID} = Installation damage reduction factor

RF_D = Durability reduction factor

S_{rs} = Reinforcement strength needed to resist the static component of load

S_{rt} = Reinforcement strength needed to resist the transient component of load

S_v = Vertical spacing of soil reinforcement

T_{max} = Maximum soil reinforcement tensile load

The reinforcement strength required for the static component, S_{rs} must be added to the reinforcement strength required for the transient component, S_{rt} to determine the ultimate reinforcement strength, T_{ult}.

$$T_{ult} = S_{rs} + S_{rt}$$

3. **Inextensible Reinforcement:** The allowable tensile load per width of steel soil reinforcement, T_a, shall be determined by the following equation:

$$T_a = FS \frac{A_c F_y}{b}$$

Inextensible reinforcement such a steel strips or bar mats will only require manufacturer's certification of the steel yield strength, F_Y, Parameters for inextensible reinforcement strength calculations are defined in Figure 30. Allowable tensile stress, T_a, for steel reinforcements and connections shall consider the loss in steel reinforcement area due to corrosion. The area of steel at the end of the design life, A_c, shall be computed using the corrosion rates shown in Table 7.

Table 7 - Steel Reinforcement Corrosion Rates

Material Loss	Material Loss Criteria
Galvanization	15 µm/year (0.60 mils/year) for first 2 years 4 µm/year (0. 1 6 mils/year) for subsequent years
Carbon Steel	12 µm/year (0.47 mils/year) after zinc depletion

The variable, b, shall be the unit width of the strip, sheet, or grid reinforcement element. The factor of safety, FS, for steel reinforcement shall depend on the location of stress, and design life of the MSEW structure as shown in Table 8.

Table 8 - Steel Reinforcement Factors of Safety

Stress Location	MSEW Design Life	
	Permanent	Temporary
Away from wall face	0.55	0.77
At rigid facing element (1)	0.48	0.67
At flexible facing element (2)	0.55	0.77

(1) Concrete panels or concrete modular blocks are rigid wall facings.
(2) Welded wire mesh, expanded metal, or similar facing panels are designated flexible wall facings.

8.10 MSEW CERTIFICATION PACKAGE

8.10.01 General: Prior to MSEW construction, the contractor shall submit for approval a Certification Package documenting the following MSEW design parameters as applicable to the MSEW system.

(a) Allowable Tensile Load, T_a, for extensible soil reinforcement (geosynthetic).

(b) Allowable connection load, T_{ac}, between MSEW extensible soil reinforcement (geosynthetic) modular concrete block facing.

(c) Soil reinforcement pullout friction coefficients (F^*, α).

The contractor shall include with the Certification Package the MSEW supplier's or MSEW component manufacturer's Certificate of Compliance stating that the MSEW components furnished meet the design requirements of the approved MSEW design in full accordance with all test methods and standards specified. In case of a dispute over the validity of values, testing shall be performed by DOTD. For tests unable to be performed by DOTD, the engineer will require the contractor to supply test data from a DOTD approved independent laboratory to support the certified values, at no additional cost to the Department.

8.10.02 MSEW Certification of Allowable Tensile Load, T_a, for Extensible Reinforcements:

1. **General:** The Certification Package shall document the allowable tensile load, T_a, multiplied by the reinforcement coverage ratio, R_c, meets or exceeds the MSEW's maximum applied tensile load, T_{max}.

2. **Allowable Tensile Load (T_a):** The allowable tensile load per width of geosynthetic soil reinforcement shall be determined by the following equation:

$$T_a = \frac{T_{ULT}}{FS\ RF}$$

A. **Ultimate Tensile Strength (T_{ULT}):** The ultimate tensile strength, T_{ULT}, shall be determined from wide width tensile tests (ASTM D 4595) or rib tensile test for geogrids (GRI:GG1). Geogrid samples tested in accordance with ASTM D 4595 shall have at least two geogrid apertures and a minimum gage length of 4 inches. All geogrid strength tests (ASTM D 4595 and GRI:GG1) shall be conducted at a strain rate of 10% per minute based on actual gage length necessary to meet the testing sample dimension requirements. Laboratory test results documenting the ultimate tensile strength, T_{ULT}, in the reinforcement direction shall be based on the minimum average roll values (MARV) for the product.

B. **Factor of Safety (FS):** The minimum factor of safety, FS, for permanent MSEW structures shall be 1.5. Temporary MSEW structures shall have a minimum factor of safety, FS, of 1.2.

C. **Reduction Factor (RF):** The total reduction factor, RF, is the combined reduction factor for long-term degradation due to creep, installation damage, and durability. The total reduction factor, RF, shall be defined as follows:

$$RF = RF_{ID} \times RF_{CR} \times RF_{D}$$

The individual reduction factors shall be documented in accordance with, and as related to, the MSEW site conditions specified in the plans, design calculations, and specifications. When sufficient documentation is not provided for individual reduction factors, the default reduction factors indicated in GEDG section 8.11 shall be used. The reinforcement manufacturer shall certify and document the individual reduction factors as follows:

(a) **Installation Damage Reduction Factor (RF_{ID}):** The reduction factor for installation damage, RF_{ID}, shall be documented by field and laboratory test results and literature review, as described in ASTM D 5818 for the MSEW backfill specified or for more severe soils. Samples subjected to installation damage shall be tested for tensile strength and deformation characteristics in accordance with ASTM D 4595 (modified for geogrid testing). Recommended values for reduction factors for installation damage (RF_{ID}) for various soils shall also be documented. The minimum installation damage reduction factor, RF_{ID}, shall be 1.1, regardless of product specific test results.

(b) **Creep Reduction Factor (RF_{CR}):** Laboratory test results documenting creep performance over a range of load levels, for a minimum duration of 10,000 hours based on tension creep test (ASTM D 5262) shall be required. Creep test samples shall be of sufficient width to be representative of overall product creep response (fiber creep testing will not be accepted).

The creep-limiting strength, T_l, shall be based on extrapolating the 10,000 hours (or longer duration) tension creep tests to a 75 year design life, unless a 100 year design life is specified in the plans. The creep extrapolation method shall be based on methods described in Appendix "B" of FHWA-SA-96-071, *"Mechanically Stabilized Earth Walls and Reinforced Soil Slopes"*. Laboratory test results and extrapolation methodology shall be documented.

The reduction factor for creep, RF_{CR}, is defined as the ratio of the average lot specific ultimate tensile strength, T_{ULTLOT}, to the creep-limiting strength, T_l. The average lot specific ultimate tensile strength, T_{ULTLOT}, for the lot of material used for creep testing, T_{ULTLOT}, shall be determined from wide width tensile test, ASTM D 4595, (modified for geogrid testing as required in 8.10.02 (Ultimate Tensile strength, T_{ult}).

(c) **Durability Reduction Factor (RF_D):** The total reduction factor for durability, RF_D, shall be defined as the combined effects of chemical and biological degradation. Laboratory test results, extrapolation techniques, and a comprehensive literature review shall document the reduction factor for durability for all material components in accordance with FHWA-SA-96-072, *"CorrosionlDegradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes"*. The minimum durability reduction factor, RF_D, shall be 1.1, regardless of product specific test results.

8.10.03 MSEW Certification for Modular Concrete Block Facing/Soil Reinforcement Connection Strength Design:

1. **General:** The certification package shall document the allowable connection load, T_{ac}, multiplied by the reinforcement coverage ratio, R_c, shall meet or exceed the MSEW maximum applied load to the soil reinforcement connection, T_o at each level of reinforcement placement at the wall facing. The soil reinforcement connection to the facing shall be accomplished through embedment between the facing elements using a partial or full friction connection.

2. **Vertical Confining Pressure:** Allowable connection loads for various levels of soil reinforcement shall be determined at the anticipated vertical confining pressure at the wall face between the facing blocks. The vertical confining pressure shall be calculated using the "Hinge Height Method" as described in AASHTO Figure 5.8.7.2A.

3. **Allowable Precast Modular Concrete Block Facing Connection Load (T_{ac}):** The allowable connection load, T_{ac}, per unit width of reinforcement at the connection shall be computed by reducing T_{ULT} for the backfill reinforcement using the connection strength determined from laboratory testing. This connection strength is based on the lesser of the pullout capacity of the connection and the long-term rupture strength of the connection.

$$T_{ac} = \frac{T_{ULT} \times CR_u}{FS \times RF_c} \leq \frac{T_{ULT} \times CR_s}{FS}$$

The global safety factor, FS, shall be 1.5 for permanent MSEW and 1.2 for temporary MSEW structures. The T_{ULT} in the reinforcement direction shall be as documented as described in GEDG subsection 8.10.02.

The connection strength resulting from pullout or rupture shall be obtained by using the NCMA Test SRWU-1 as modified herein.

- **(a)** The "Zero" tension is defined as 1.1 kN/m (75 lbs./ft)
- **(b)** The specimen width shall range from 750 mm to 1000 mm (30 inches to 40 inches).
- **(c)** The specimen width shall be an exact multiple of the facing lock width

The reduction factor to account for the reduced ultimate strength resulting from rupture at the connection, CR_u, and the reduction factor to account for reduced strength due to connection pullout, CR_s, shall be determined at the anticipated vertical confining pressure at the wall face between the facing blocks. The vertical confining pressure shall be calculated using the Hinge Height Method. The CR_u and CR_s shall be computed as follows:

Rupture Reduction Factor: **Pullout Reduction Factor:**

$$CR_U = \frac{T_{ultc}}{T_{lot}} \qquad CR_s = \frac{T_{sc}}{T_{lot}}$$

The T_{ultc} shall be defined as the peak load per unit of reinforcement width, which results in rupture of the reinforcement in this test at the specified confining pressure. The T_{sc} shall be defined as the peak load per unit of reinforcement width at a specified maximum deformation of 15 mm (0.6 inches) or at the peak pullout load, whichever occurs first. The T_{lot} is defined as the ultimate tensile strength (ASTM D4595 modified for geogrids when required) for the reinforcement material lot used for the connection strength testing.

The total connection reduction factor, RF_c, accounts for the potential long-term degradation of the reinforcement at the wall face connection due to environmental factors. The total connection reduction factor, RF_C, shall be defined as follows:

$$RF_C = RF_{CR} \times RF_D$$

The individual reduction factors for creep (RF_{CR}) and durability (RF_D) shall be documented in accordance with the MSEW site conditions specified in the plans, design calculations, and these specifications. The reinforcement manufacturer shall certify the individual reduction factors by providing the documentation in accordance with GEDG subsection 8.10.02. When sufficient documentation is not provided for the individual reduction factors (RF_{CR}, RF_D), the default reduction factors indicated in GEDG subsection 8.11.04 shall be used. When the total reduction factor, RF_C, value is obtained using default values it shall not exceed the total default connection factor, $RF_{CDefault}$, specified in GEDG subsection 8.11.03.

8.10.04 MSEW Certification of Soil Reinforcement Pullout Coefficients (F*, α): The Certification Package shall document the pullout coefficients (F*, α) meet or exceed the MSEW's required design pullout coefficients.

The pullout friction factor, F*, and the scale effect correction factor, α, shall be documented by laboratory testing from pullout tests. Pullout testing shall be conducted for site specific materials or for materials representative of the reinforced backfill specified for the MSEW at confining pressures ranging from 13.8 to 68.9 kPa (2 to 10 psi). When laboratory tests are used from representative soils, the representative soils shall be documented by providing the soil gradation. Recommended pullout coefficients for various soil types shall also be documented. The pullout coefficients shall be determined by using the quick effective stress pullout tests ("Controlled Strain Rate Method for Short-Term Testing" per GRI:GG5 and GRI:GT6) and through-the-junction creep testing of the geogrid per GRI:GG3a. When sufficient documentation is not provided for pullout coefficients, F* and α, the default values indicated in GEDG section 8.12 shall be used.

8.11 DEFAULT REDUCTION FACTORS

8.11.01 General: Individual default reduction factors have been established for those submittals where sufficient documentation of the individual reduction factors is not provided. In order to use default total and individual reduction factors, the geosynthetic reinforcement shall meet the properties shown in Table 8. The default total Reduction Factor, $RF_{Default}$, and default total connection factor, $RF_{CDefault}$, shall be used when **none** of the individual reduction factors have been adequately documented.

If the geosynthetic reinforcement does not meet the requirements in Table 8, the individual default values shall not be used and a default total reduction factor, $RF_{Default}$ of 10 shall be used for permanent MSEW structures and a $RF_{Default}$ of 5 shall be used for temporary MSEW structures. A default total connection reduction factor, $RF_{Default}$, of 6 shall be used for permanent MSEW structures and a $RF_{Default}$ of 3.5 shall be used for temporary MSEW structures.

8.11.02 Default Total Reduction Factor, $RF_{Default}$: For geosynthetic reinforcement meeting the properties shown in Table 8 the default total reduction factor, $RF_{Default}$, shall not be less than 7.0 for permanent MSEW structures and shall not be less than 3.5 for temporary MSEW structures.

8.11.03 Default Total Connection Reduction Factor, $RF_{CDefault}$: For geosynthetic reinforcement meeting the properties shown in Table 8 the default total connection reduction factor, $RF_{CDefault}$, shall not be less than 4 for permanent MSEW structures and shall not be less than 2.5 for temporary MSEW structures.

Table 8 - Minimum Geosynthetic Reinforcement Properties To Allow Use of Default Total Reduction Factor, RF

Type	Property	Test Method	Minimum Criteria
Polypropylene Or Polyethylene	UV Oxidation Resistance	ASTM D 4355	Minimum 70% strength retained after 500 hrs. in weatherometer
Polyester	Hydrolysis Resistance	Inherent Viscosity Method (ASTM D 4603 and GRI Test Method GG8) or Determine Directly Using Gel Permeation Chromatography	Minimum Number (Mn) Molecular Weight of 25,000
Polyester	Hydrolysis Resistance	GRI GG7	Maximum Carboxyl End Group Number of 30
All Polymers	Survivability	Weight per Unit Area ASTM D 5261	Minimum 270 g/m^2
All Polymers	% Post Consumer Recycled Material by Weight	Certification of Material Used	Maximum 0%

8.11.04 Default Individual Reduction Factors: The individual default reduction factors for geosynthetic reinforcement meeting the properties shown in Table 8 are based on the type of geosynthetic reinforcement and type of reinforced backfill. The type of geosynthetic is based on the geosynthetic structure and composition. Geosynthetic structure will be either geogrid or geotextile. Geosynthetic composition shall be classified as one of the following: high density polyethylene (HDPE), polyester (PET), and polypropylene (PP). The reinforced backfill material shall be either granular backfill or stone backfill. The total reduction factor, RF, and the total connection reduction factor, RF_c, based on the combined individual reduction factors (documented and default values) shall not exceed the default total reduction factor, $RF_{Default}$, in subsection 8.11.02 nor the default total connection factor $RF_{CDefault}$ provided in subsections 8.11.03.

(a) **Installation Damage Reduction Factor (RF_{ID}):** In the absence of specific data, the default values for the installation damage reduction factor, RF_{ID}, shown in Table 9 should be used.

Table 9 - Default Installation Damage Reduction Factor, RF_{ID}

No.	Geosynthetic Type	RF_{ID} Granular Backfill	RF_{ID} Stone Backfill
1	HDPE Uniaxial Geogrid	1.20	1.45
2	PP Biaxial Geogrid	1.20	1.45
3	PVC Coated PET Geogrid	1.30	1.85
4	Acrylic Coated PET Geogrid	1.40	2.05
5	Woven Geotextiles PP & PET	1.40	2.20
6	Nonwoven Geotextiles PP & PET	1.40	2.50
7	Slit Film Woven PP Geotextile	2.00	3.00

(b) **Creep Reduction Factor (RF_{CR}):** In the absence of specific data, the default values for the creep reduction factor, RF_{CR}, shown in Table 10 should be used.

Table 10 - Default Creep Reduction Factor, RF_{CR}

No.	Polymer Type	RF_{CR}
1	Polyester (PET)	2.0
2	Polypropylene (PP)	4.0
3	Polyethylene (HPDE)	3.0

(c) **Durability Reduction Factor (R_{FD}):** In the absence of specific data, the default values for the durability reduction factor, RF_D, shown in Table 11 should be used. Default durability reduction factors for polyester geosynthetics shall be restricted to polyesters having the specified molecular weight, M_n, and Carboxyl End Group, CEG shown in Table 11.

Table 11 - Default Durability Reduction Factor, RF_D

No.	Geosynthetic Type	RF_D
1	Polyester (PET) Coated Geogrid (M_n>25,000, CEG<30	1.15*
2	Polypropylene (PP) Geogrid	1.5
3	Polyethylene(HPDE) Geogrid	1.1
4	Polyester (PET) Geotextiles (M_n<20,000, 40<CEG<50	1.6
5	Polypropylene (PP) Geotextile	2.0

* **Note:** If M_n or CEG values are not documented use RF_D=2.0

8.12 DEFAULT PULLOUT COEFFICIENTS

8.12.01 General: Default methods of estimating pullout coefficient values have been established for those submittals where sufficient documentation of the pullout coefficients is not provided. In order to use these default methods of determining pullout coefficients the coefficient of uniformity ($C_u = D_{60}/D_{10}$) of the backfill material shall be greater than or equal to 4. If the coefficient of uniformity ($C_u = D_{60}/D_{10}$) of the backfill material is less than 4, laboratory pullout test shall be required in accordance with GEDG 8.10.04.

8.12.02 Pullout Friction Factor, F*: In the absence of specific data the default pullout friction factor, F*, shown in Figure 31 shall be used. If the coefficient of uniformity, C_u, is not known at the time of design of ribbed steel strip reinforcements, a coefficient of uniformity, C_u, of 4 shall be used.

8.12.03 Scale Effect Factor, α: In the absence of specific data, the default scale effect factor, α, shown in Table 12 shall be used.

Table 12 - Default Scale Effect Factor, α

Type of Soil Reinforcement	Scale Effect Factor α
Inextensible Reinforcement	1.0
Geogrid Reinforcement	0.8
Geotextile Reinforcement	0.6

8.13 FINAL DESIGN DRAWINGS FOR PRE-DESIGNED SYSTEM BASED CONTRACTING METHOD

8.13.01 General: The drawings shall be made on standard size 560 mm x 915 mm (22 inches x 36 inches) sheets. Top, bottom and right margins shall be at least 15 mm (½ inch), and the left margin shall be at least 40 mm (1½ inches). Each sheet shall have a title block in the lower right corner with the state project number, project name, parish, MSEW system name, MSEW system supplier address and phone number, sheet number, date, and revision block.

8.13.02 Layout Requirements: The final design plans shall include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines, shown in the MSEW Control Plans. The vertical bearing pressure exerted by the MSEW structure, relative to changes in wall height and soil reinforcement length shall be shown clearly on the plans. The final design plans shall also reflect all information needed to fabricate and erect the walls including:

1. Existing ground elevations that have been verified by the contractor for each location.
2. MSEW profile elevation showing top of the leveling pad elevations, maximum bearing loads, top of wall elevation, etc.;
3. Details of slip joints if required to prevent stresses due to anticipated settlement shown on the plans;
4. Details of all joints indicating type, size, and manufacturer;
5. Details of wall batter;
6. Shape and dimensions of MSEW facings;
7. The number, size, type, and details of the soil reinforcing elements;
8. Details of facing/reinforcement connections;
9. Details showing location and installation of geotextile fabric;
10. Details of leveling pad showing dimensions;
11. Finishing details at top of wall (i.e. cap block, panel coping)
12. Details at miscellaneous obstructions (i.e. utility conduits) located below the ground surface;
13. Details at bridge foundation obstructions;
14. Dimensions of structural backfill required;
15. Any additional details pertaining to coping, railing, temporary facing, and internal drainage, as required by the contract plans.

813.03 **Top of Wall:** Written approval will be required to lower the top of wall elevations shown on the plans. The top of wall elevation for MSEW with modular concrete block facing may be increased to a maximum of 205 mm (8 inches) without written approval and shall not increase the pay quantity shown in the plans. The top of wall elevations shall be such as to allow for proper interfacing with barriers copings, surface ditches, bridge abutments, etc. as shown in the plans.

813.04 **Leveling Pad:** Written approval shall be required to raise the leveling pad elevations shown on the MSEW Control Plans. Leveling pad embedment depths shown in the plans may be increased to a maximum of 0.5 m (20 inches) without written approval and shall not increase the pay quantity shown in the plans. The leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown on the plans.

813.05 **Special Wall Interface Details:** Should conditions arise within this project where a wall interfaces with another wall that will be constructed before, on, or after this contract, the final design plans shall contain special facing element details, wing wall slip joint details, and details on how to end this wall or walls and how to compact the embankment at these locations. The wall ends shall not be placed over pile supported footings.

For MSEW with precast concrete panel facings, the columns of panels that are adjacent to the interface location on this project shall be modified in order to phase out the joint line produced under normal conditions to a joint that is vertical at the interface. The panels shall be modified as follows.

1. The modified panels shall be 50 mm (2 inches) thicker than the normal panel.
2. The side of the panel that coincides with the interface line shall be keyed in order to mate with the adjacent panel on the adjacent project.
3. The horizontal joint lines for the adjacent panels on either side of the interface shall be offset vertically by ½ panel.

813.06 **Earth Surcharges:** Should the MSEW Control plans indicate an earth surcharge is to be placed over the reinforced zone, the surcharge may be retained by using a temporary MSEW structure.

813.07 **Precast Concrete Panel Facing Layout:** MSEW with precast concrete panel facing shall require a numbered panel layout drawing for fabrication and erection purposes.

8.14 CONSTRUCTION SPECIFICATIONS

8.14.01 General: Construction special provisions for permanent and temporary MSEW have been developed. All methods of contracting permanent MSEW structures will use a specification for MSEW Structural Excavation and Backfill. Specifications for permanent MSEW structures have been developed based on the type of contracting method: Pre-Qualified System Based and Pre-Designed System Based. Construction special provisions for temporary MSEW have also been developed.

Sample construction specifications are provided in Appendix C for informational purposes. These specifications are subject to change without notice. For the latest version of these specifications contact the Department's Contracts and Specifications Section.

8.14.02 MSEW Structural Excavation And Backfill Specifications: This special provision provides specifications and a pay item for structural excavating, disposing, dewatering, and backfilling of materials below the original ground line to facilitate placement of the reinforced backfill. A sample specification is provided in Appendix C.

8.14.03 Pre-Qualified System Based Specifications: This special provision provides the design requirements, MSEW component requirements, construction procedures, and a pay item necessary to design and construct an MSEW structure. A sample specification is provided in Appendix D.

8.14.04 Pre-Designed System Based Specifications: This special provision provides the MSEW component requirements, construction procedures, and a pay item necessary to construct an MSEW structure. No design requirements are specified since all designs have been reviewed and approved during the plan preparation phase of the project. A sample specification is provided in Appendix E.

8.14.05 Temporary MSEW Specifications: This special provision provides the design requirements, MSEW component requirements, construction procedures, and pay item necessary to design and construct a Temporary MSEW structure. Special provisions for temporary MSEW can be provided as the only retaining method or as an alternate to other retaining methods such as steel sheet pile. A sample specification is provided in Appendix F.

8.15 REVIEW AND APPROVAL OF MSEW WORKING (SHOP) DRAWINGS AND SUPPORTING DOCUMENTS

8.15.01 General: The MSEW system supplier is responsible for providing working (shop) drawings and supporting documents. Supporting documents include MSEW Certification Package (T_a, T_{ac}, F^*, α), design computations, etc. When the Pre-qualified System Based or Temporary MSEW contracting method is used, the working drawings and supporting documents are submitted to the Department during the construction phase of the project. When the Pre-designed System Based contracting method is used, the working drawings and supporting documents are submitted to the project coordinator for review and approval prior to 95% Final Plans (ACP).

8.15.02 Review and Approval Process: When working drawings and design computations are submitted during construction, the project engineer will transmit the submittals to the Department's project design coordinator (Bridge Design or Road Design) for review and approval. Working drawings and design computations that are submitted during the design phase prior to 95% Final Plans are submitted by the MSEW system supplier to the project coordinator (Bridge or Road Design). The review of the working drawings and supporting documentation needs to be closely coordinated between the project coordinator (Bridge or Road designer) and the Pavement and Geotechnical Design Section. A flow chart of the MSEW working drawing review/approval process is shown in Appendix G-1.

8.15.03 Design Computation Review: Review and approval of the design computations will be made by the Pavement and Geotechnical Design Section. Material certifications and testing reports for the reinforced backfill and other MSEW components (i.e. modular blocks, steel strips, geotextile fabrics, etc.) will also be forwarded to the Pavement and Geotechnical Design Section for information only. This review will be made to insure that the MSEW structure has been designed in accordance with the plans and special provisions.

8.15.04 MSEW Certification Package Review and Approval: Review and approval recommendations of the MSEW Certification Package will be made by the Pavement and Geotechnical Design Section. This will insure that the MSEW component design properties meet or exceed the design requirements of the MSEW structure. Recommendation for approval/rejection will be sent directly from the Pavement and Geotechnical Design Section to the Construction division. A copy of the recommendation letter will be sent to the Materials and Testing Section to assist them with their quality assurance testing and evaluation. A flow chart of the MSEW Certification Package review/approval process is shown in Appendix G-2.

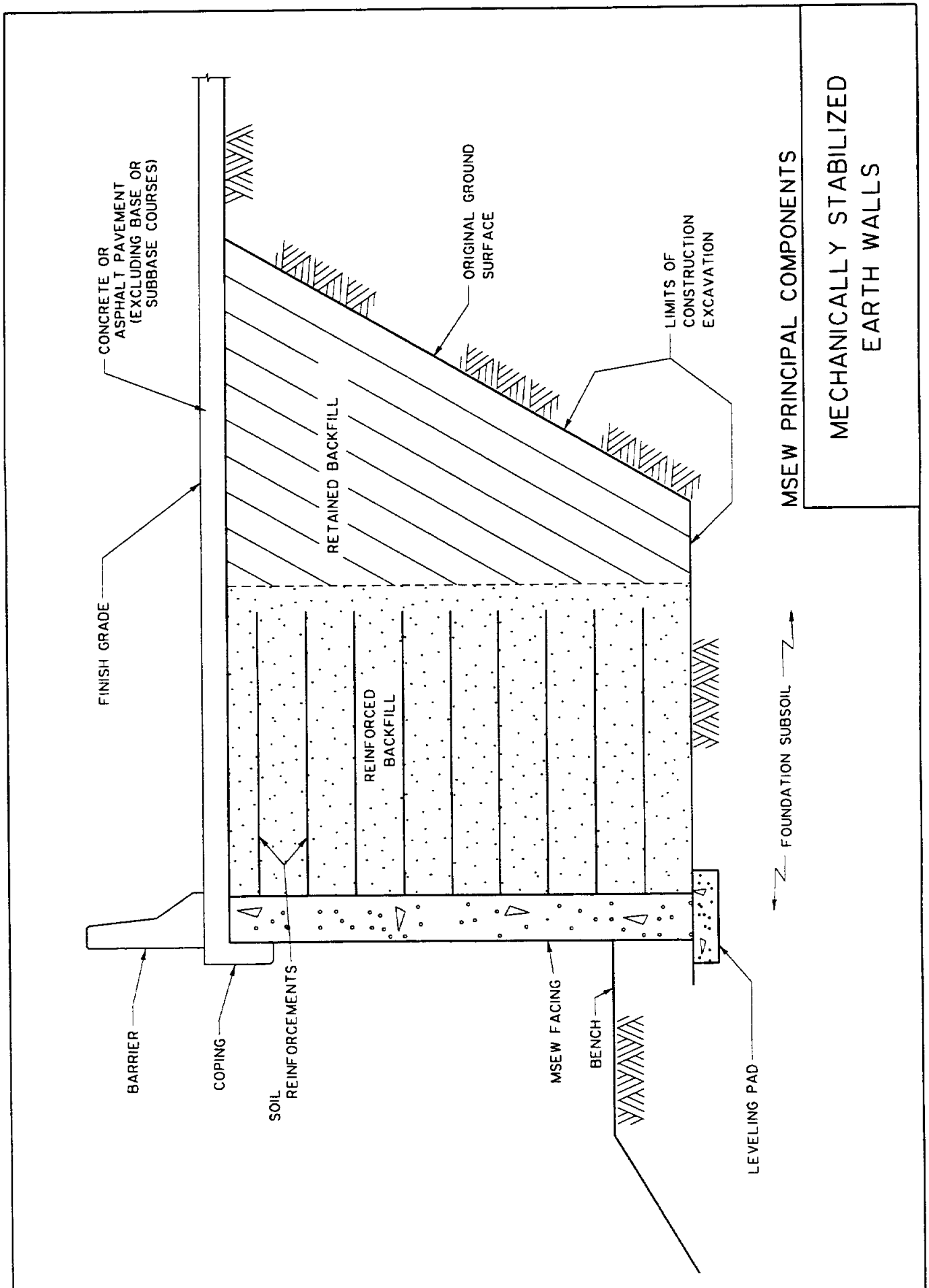
8.15.05 Working Drawing/Final Design Drawing Review: Review of the working drawings will be made jointly by the Department's project design coordinator (Bridge Design or Road Design) and the Pavement and Geotechnical Design unit. A checklist for reviewing MSEW working drawings is provided in Appendix G-3 of this guide.

APPENDIX A

FIGURES

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

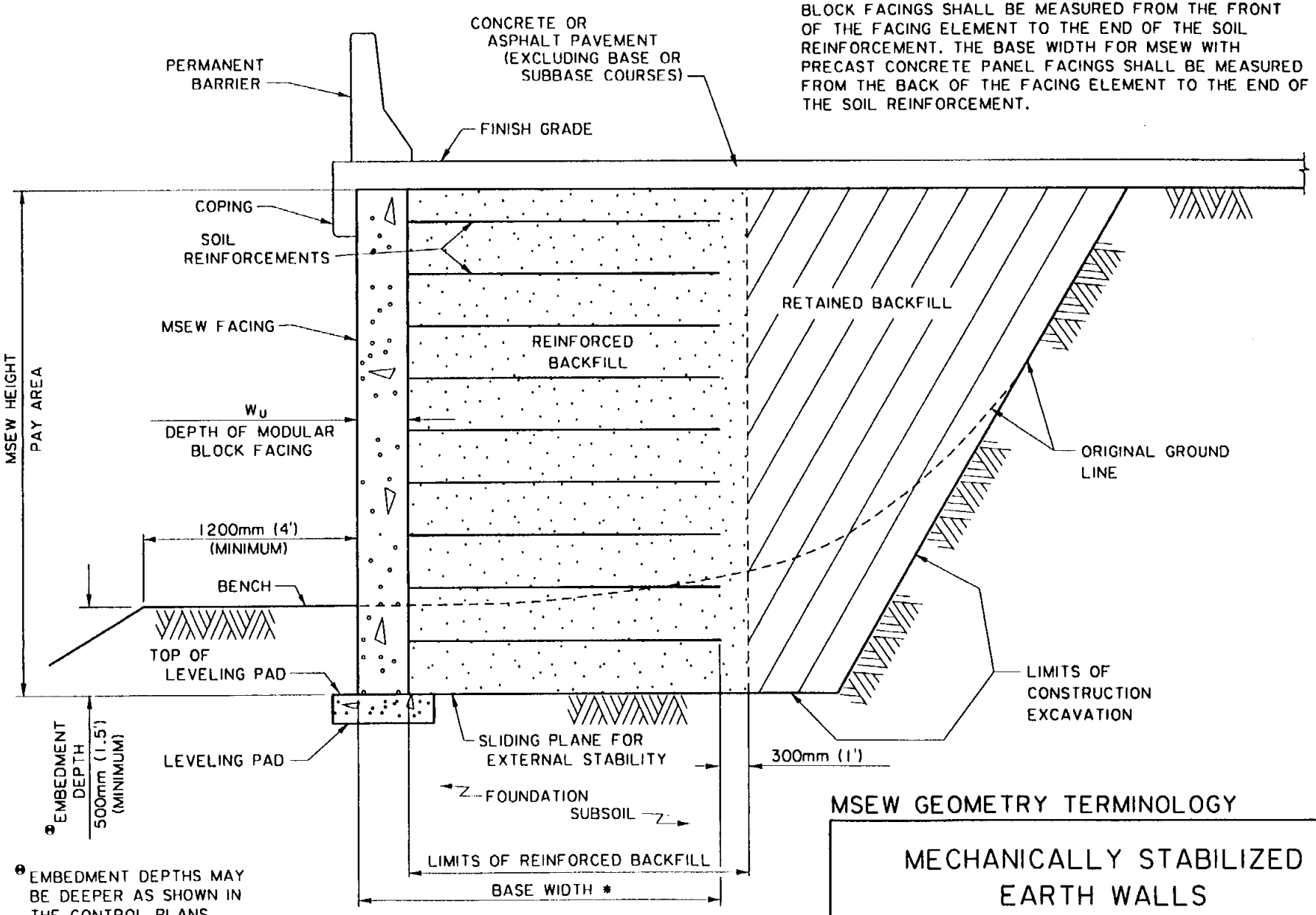
(10/1/1999)



GEDG NO. 8

FIGURE 1

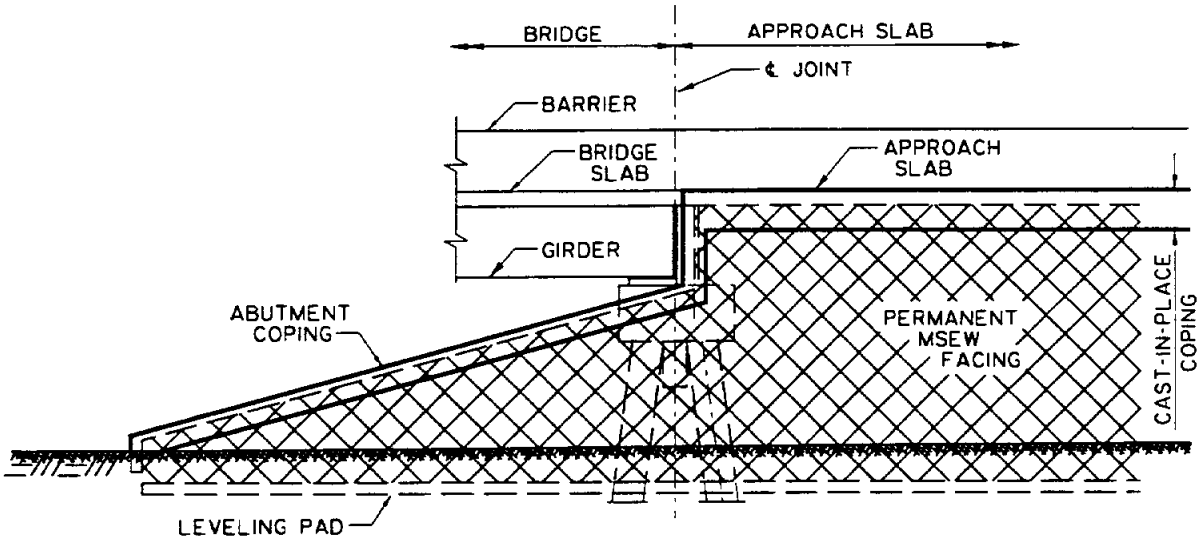
REVISED 07/22/1999



MSEW GEOMETRY TERMINOLOGY

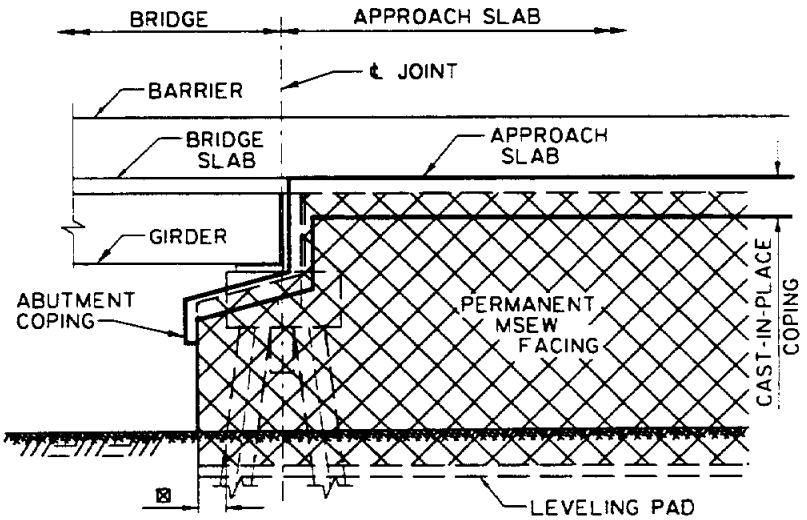
MECHANICALLY STABILIZED EARTH WALLS

FIGURE 2



DETAIL A

BRIDGE ABUTMENTS TERMINATING
WITH END SLOPES



⊠ 500mm (1.5') CLEAR DISTANCE
BETWEEN PILES/CASINGS
AND MSEW FACING

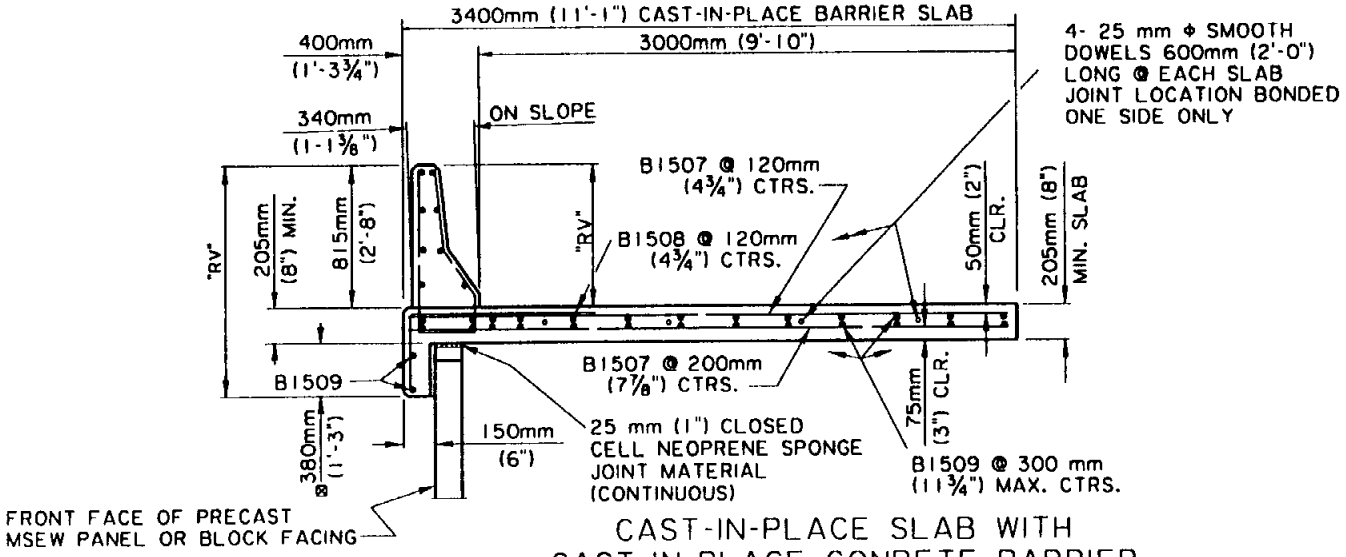
DETAIL B

BRIDGE ABUTMENTS TERMINATING
WITH VERTICAL (OR SEMI-VERTICAL)
MSE WALL FACING

BRIDGE ABUTMENT DETAILS

MECHANICALLY STABILIZED EARTH WALLS

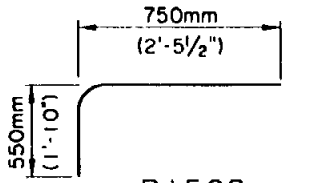
FIGURE 4



⊠ THIS DIMENSION MAY NEED AJUSTMENT DEPENDING ON THE LENGTH OF PANELS AND THE SLOPE OF THE FINISH GRADE ON THE ROADWAY.

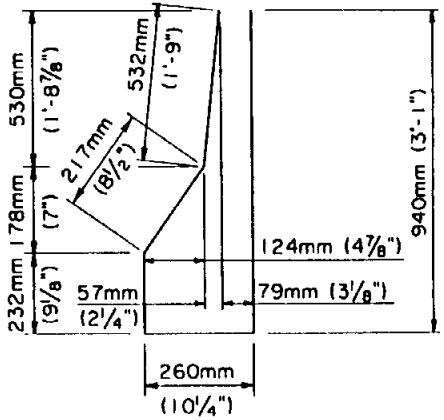
CAST-IN-PLACE SLAB WITH
CAST-IN-PLACE CONRETE BARRIER

(FOR BARRIER RAILING DETAILS, SEE STANDARD PLAN B.R.-02 OR B.R.-02M)



B1508

(100mm (4") DIA. PIN)



B1511

(60mm (2⅜") ϕ PIN)

TYPICAL CAST-IN-PLACE BARRIER DETAILS
(PANEL OR BLOCK FACING)

MECHANICALLY STABILIZED EARTH WALL

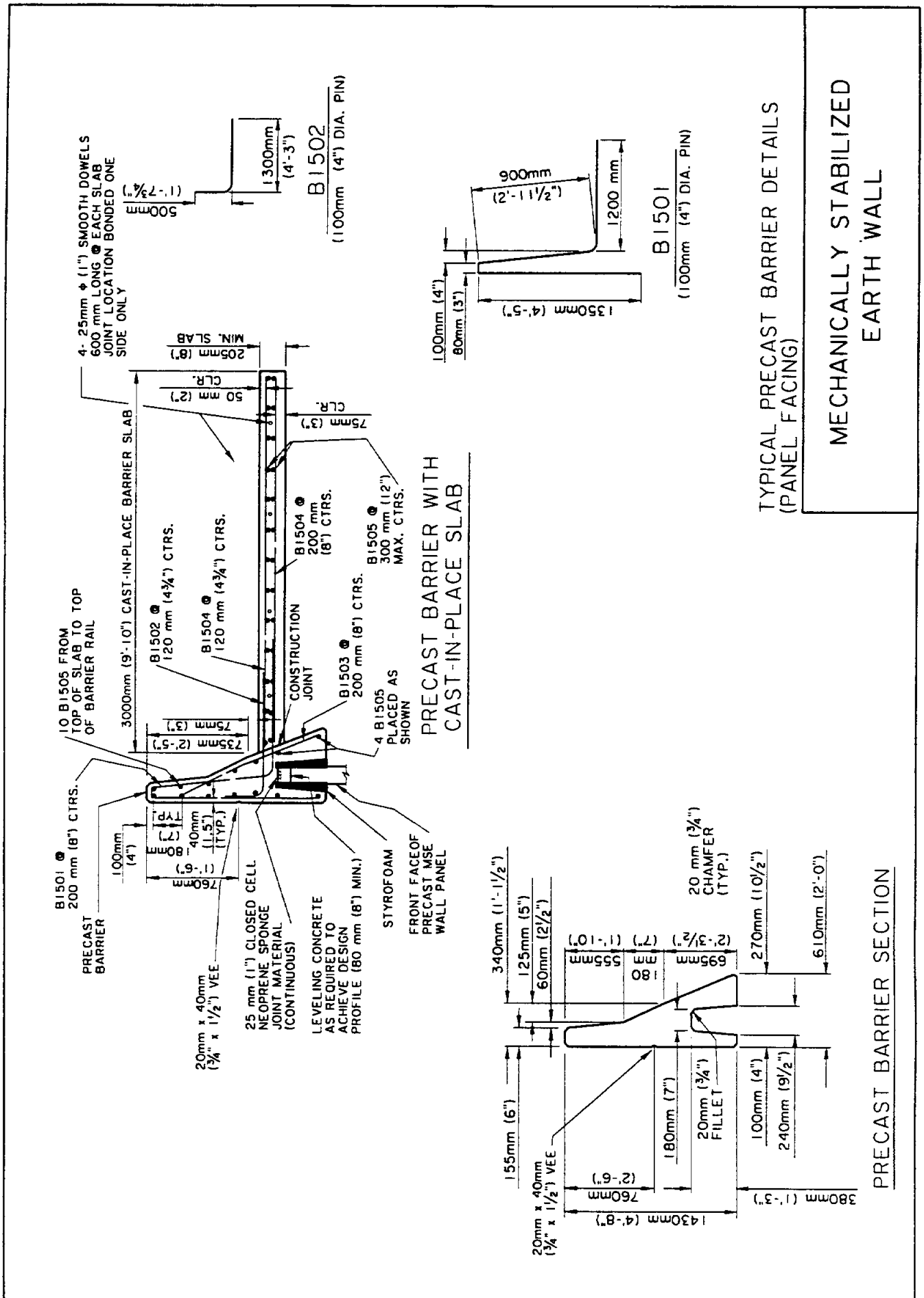
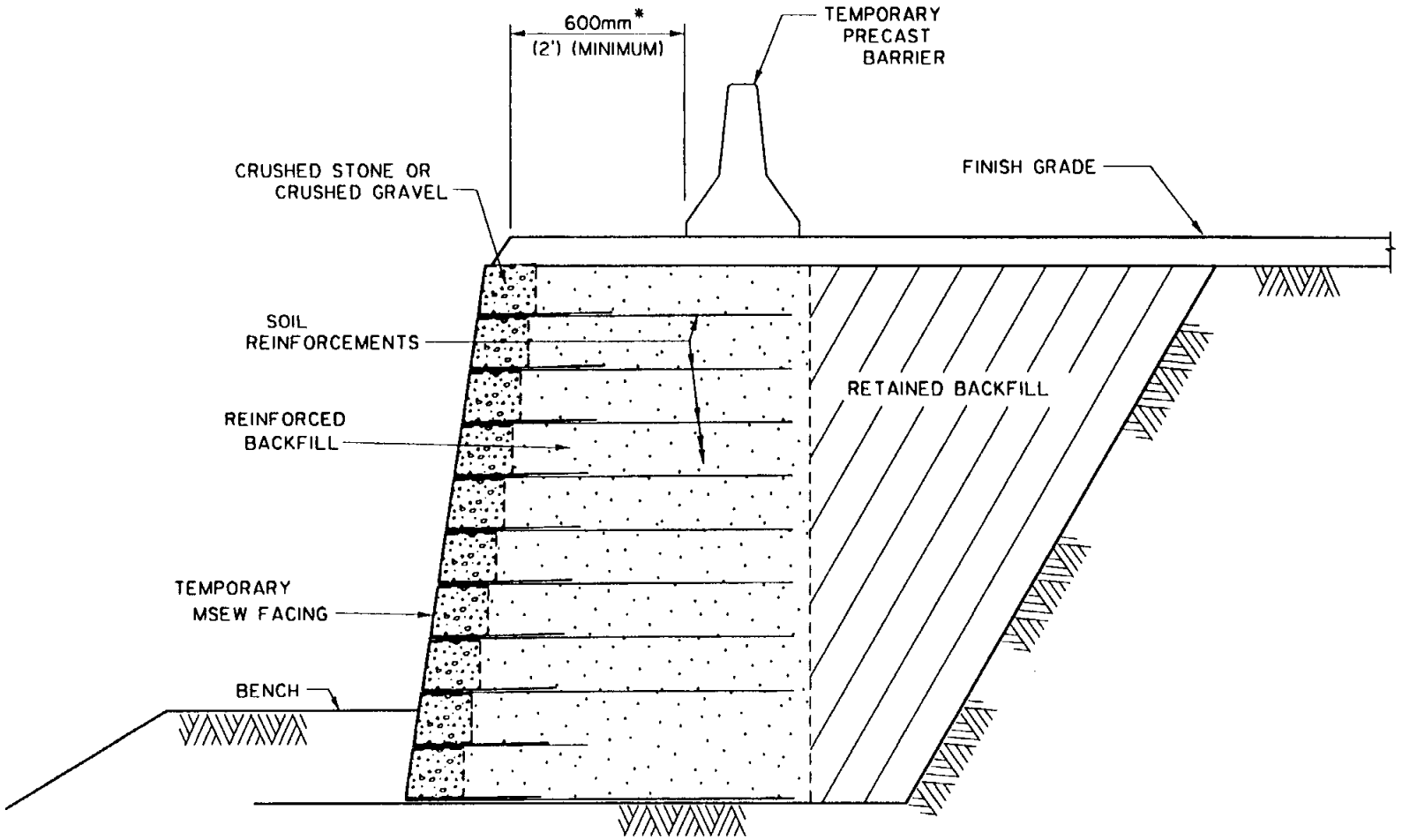


FIGURE 5

GEDG NO. 8

REVISED 04/02/1998

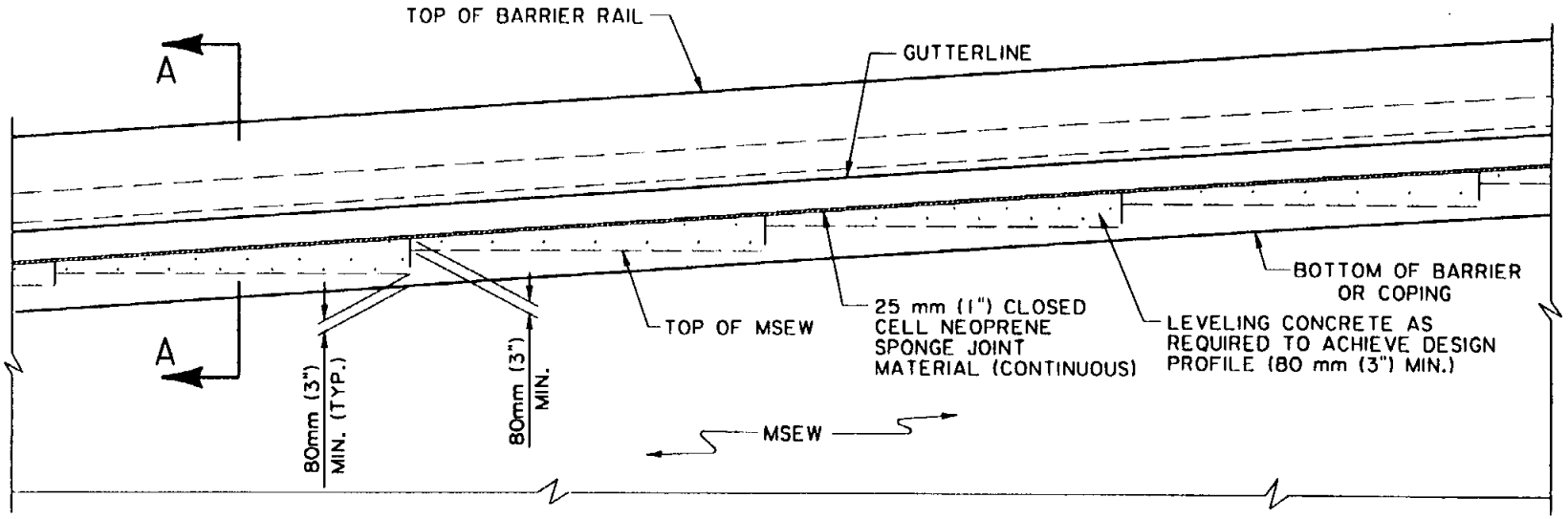
FIGURE 6



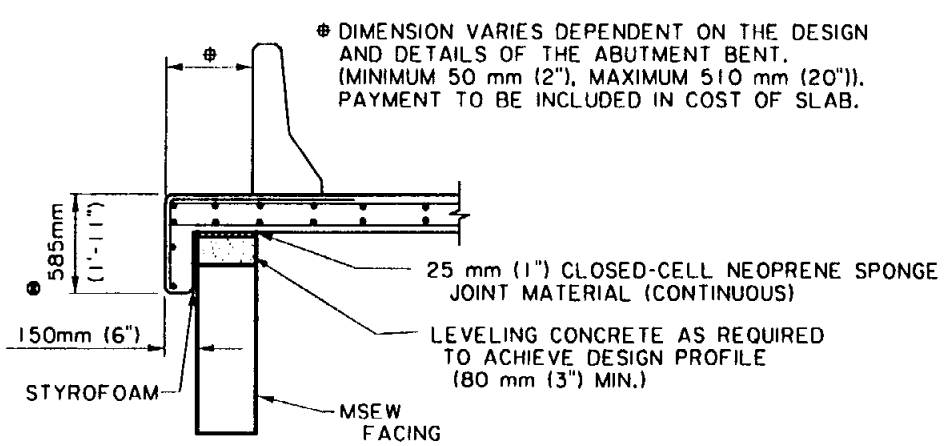
* SINGLE FACE TEMPORARY BARRIERS WILL NOT BE ALLOWED UNLESS A CLEAR DISTANCE OF 1.5m (5 FEET) IS PROVIDED.

TYPICAL TEMPORARY
PRECAST BARRIER DETAIL

MECHANICALLY STABILIZED
EARTH WALLS



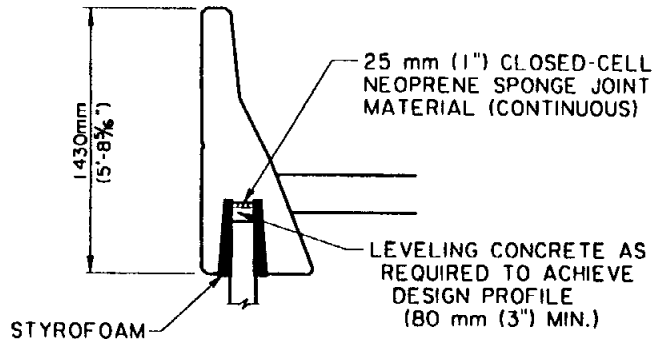
ELEVATION OF MSEW



⊕ DIMENSION VARIES DEPENDENT ON THE DESIGN AND DETAILS OF THE ABUTMENT BENT. (MINIMUM 50 mm (2"), MAXIMUM 510 mm (20")). PAYMENT TO BE INCLUDED IN COST OF SLAB.

SECTION A-A THROUGH CAST-IN-PLACE SECTION

⊕THIS DIMENSION MAY NEED ADJUSTMENT DEPENDING ON THE LENGTH OF PANELS AND THE SLOPE OF THE FINISH GRADE ON THE ROADWAY.

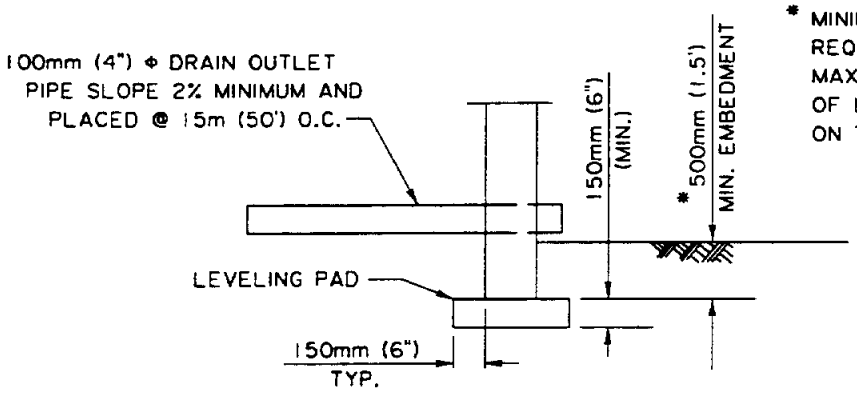


SECTION A-A THROUGH PRECAST SECTION

TYPICAL BARRIER COPING DETAILS

MECHANICALLY STABILIZED EARTH WALL

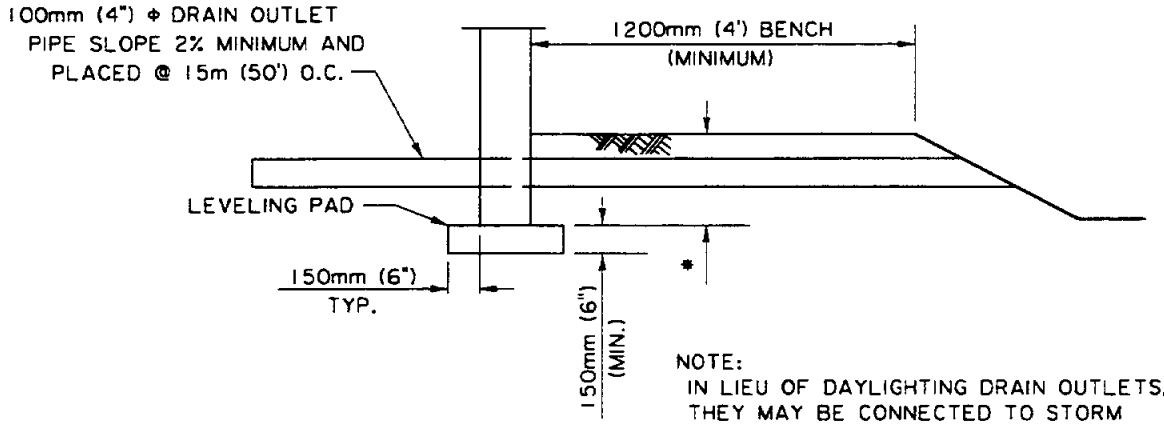
FIGURE 7



* MINIMUM EMBEDMENT AS REQUIRED TO ACHIEVE MAXIMUM ELEVATION AT TOP OF LEVELING PAD SHOWN ON THE PLANS

LEVELING PAD DETAIL

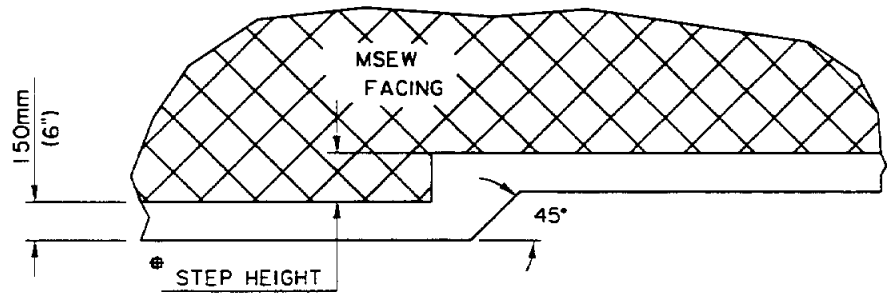
(DIMENSIONS AS PROVIDED BY THE MSEW MANUFACTURER)



NOTE:
IN LIEU OF DAYLIGHTING DRAIN OUTLETS, THEY MAY BE CONNECTED TO STORM DRAIN AS APPROVED BY THE ENGINEER.

LEVELING PAD DETAIL (ADJACENT TO SLOPE OR DITCH)

(DIMENSIONS AS PROVIDED BY MSEW MANUFACTURERS)

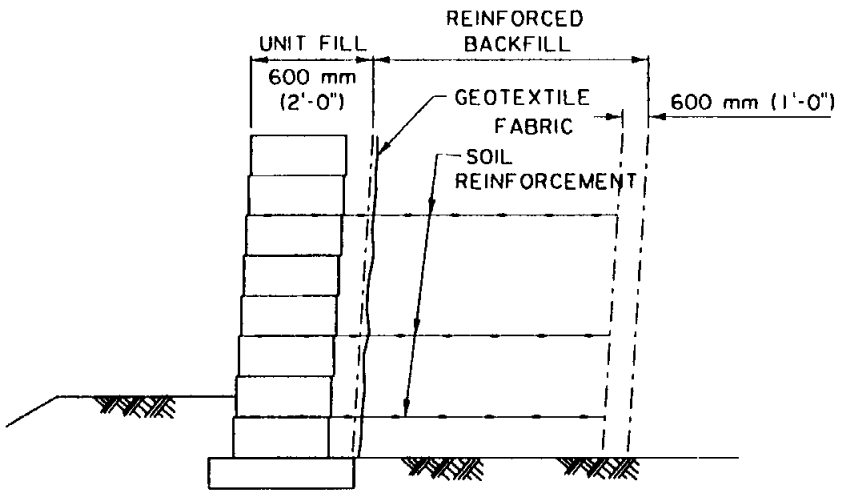


TYPICAL LEVELING PAD STEP DETAIL

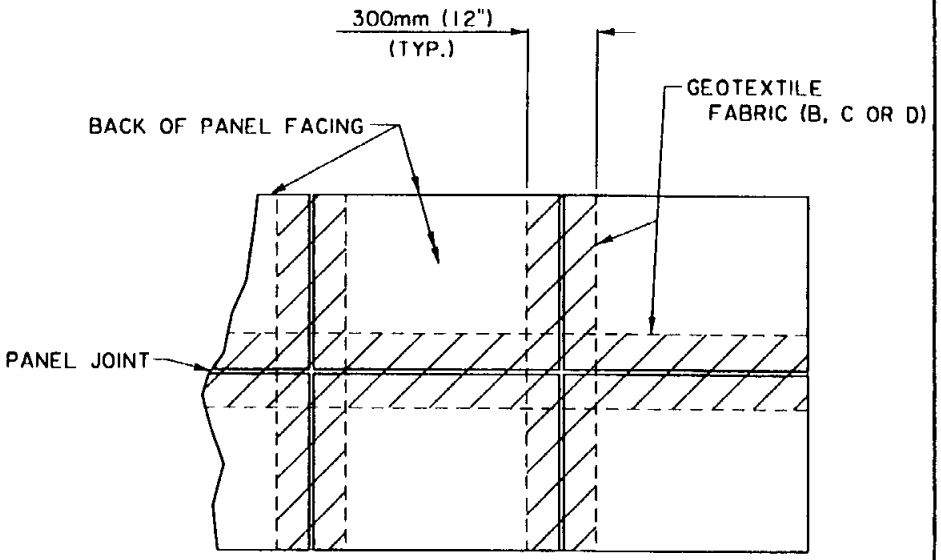
⊕ STEP HEIGHT FOR MODULAR CONCRETE BLOCK FACING SHALL BE LIMITED TO THE HEIGHT OF THE BLOCK

MSEW EMBEDMENT DETAILS

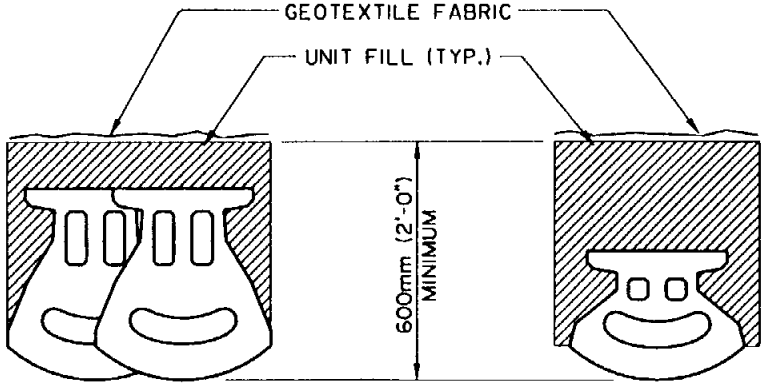
MECHANICALLY STABILIZED EARTH WALLS



SECTION THROUGH TYPICAL MSEW WITH MODULAR CONCRETE BLOCK FACING



PANEL FACING DETAIL



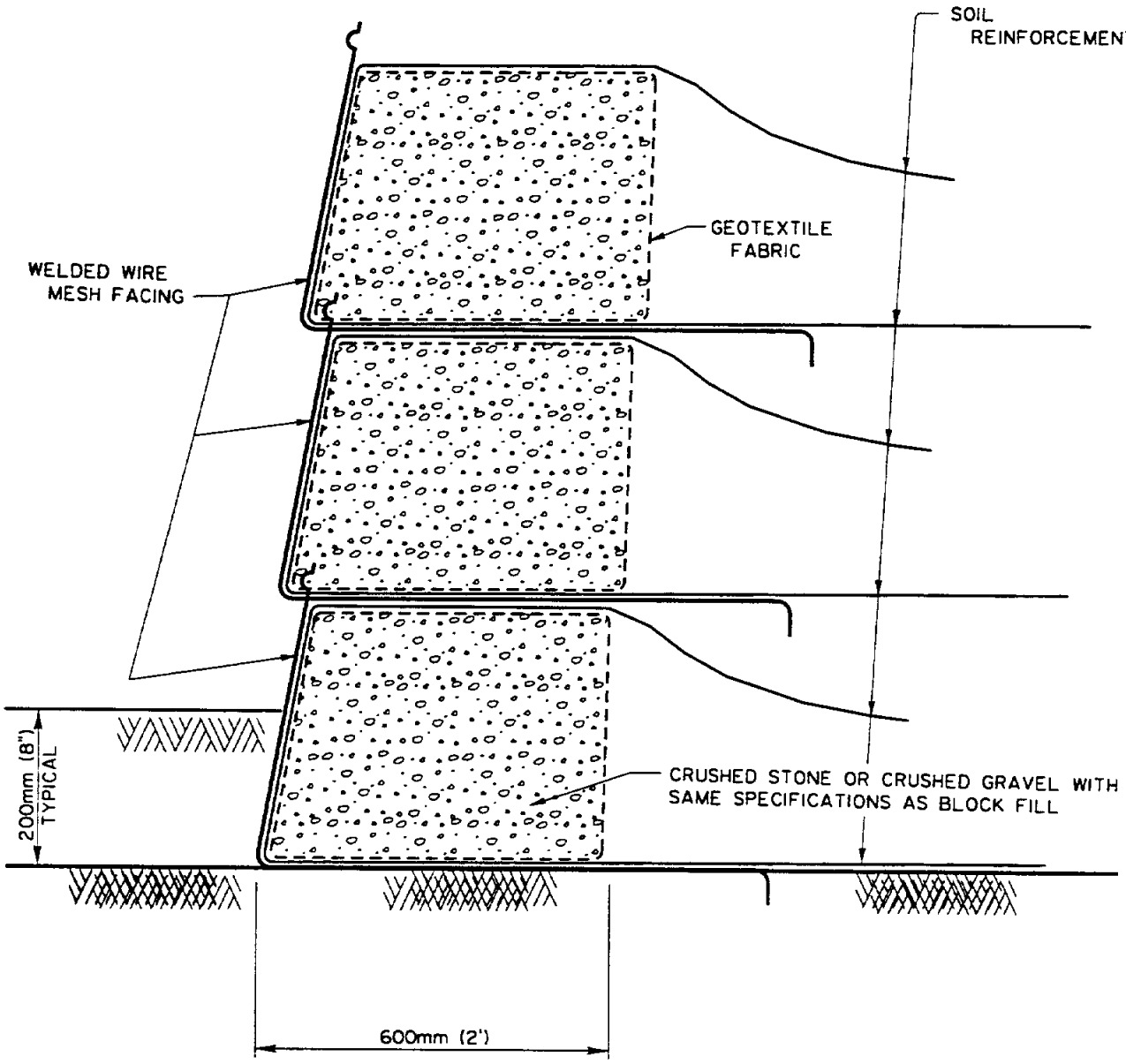
FULL DEPTH BLOCK

HALF DEPTH BLOCK

MSEW FACING DETAILS

MECHANICALLY STABILIZED EARTH WALL

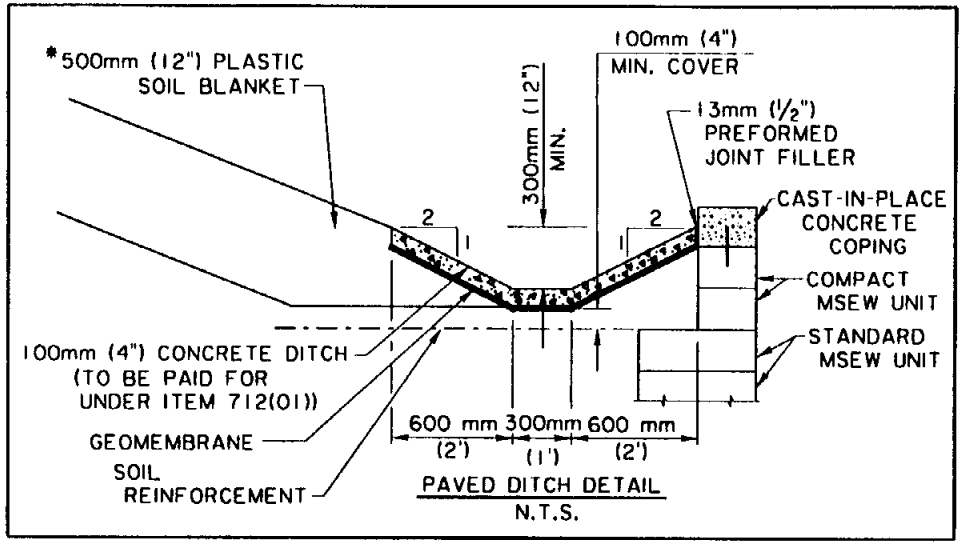
FIGURE 9



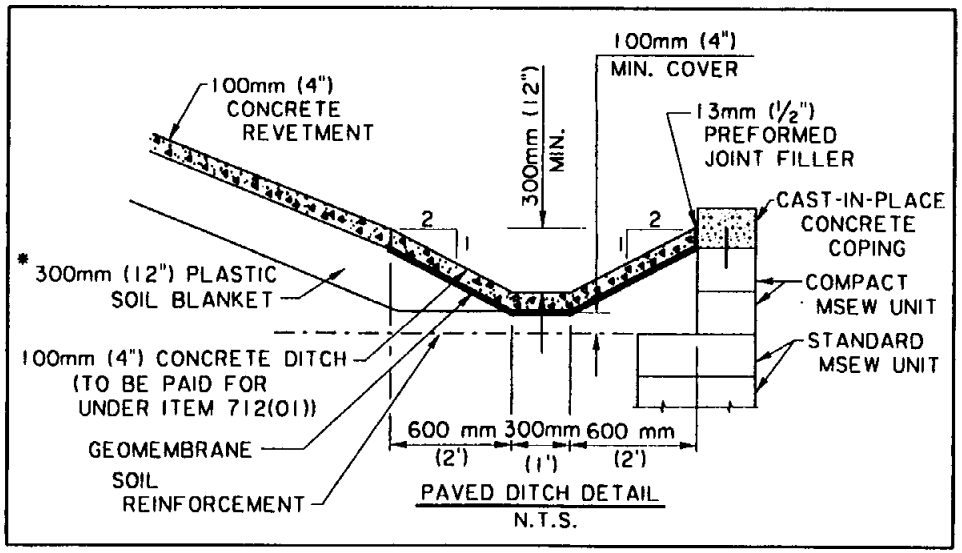
FACING FOR TEMPORARY MSEW

MSEW TEMPORARY FACINGS

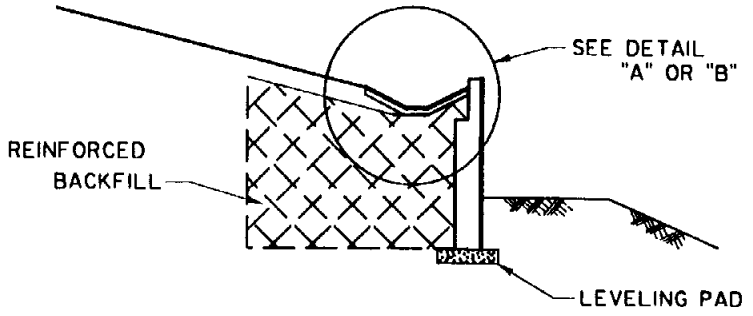
MECHANICALLY STABILIZED EARTH WALLS



EMBANKMENT SIDESLOPE
DETAIL "A"



ABUTMENT ENDSLOPE (UNDER BRIDGE)
DETAIL "B"



PAVED DITCH SECTION

* PLASTIC SOIL BLANKET REQUIRED ABOVE NON-PLASTIC EMBANKMENT OR MSEW REINFORCED BACKFILL

NOTES:
1. MSEW COPING AND GEOMEMBRANE SHALL BE PAID FOR UNDER THE MSEW PAY ITEMS.
2. THE PAVED DITCH, REVETMENT AND W6 x 6 WELDED WIRE MESH WILL BE PAID FOR UNDER A SEPARATE ITEM FROM THE MSEW PAY ITEM.

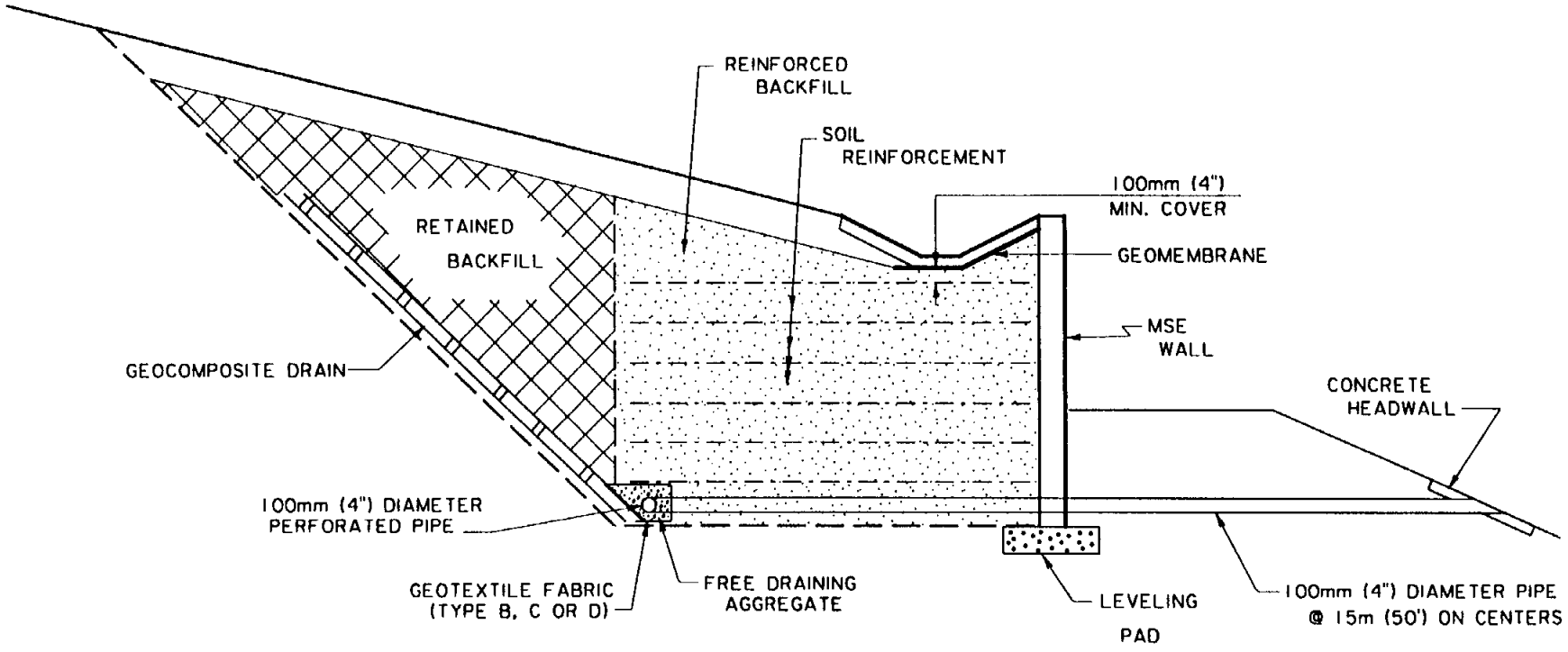
PAVED DITCH DETAILS

MECHANICALLY STABILIZED EARTH WALL

FIGURE 11

GEDG NO. 8

FIGURE 12



SECTION THROUGH GEOCOMPOSITE DRAINAGE SYSTEM

NOTE:
INTERNAL DRAINAGE FEATURES SUCH AS PIPES, PERFORATED PIPES, END TREATMENTS, GEOCOMPOSITE DRAINS, GEOTEXTILE FABRIC, AND FREE DRAINING AGGREGATE SHALL BE PAID FOR UNDER THE MSEW PAY ITEM.

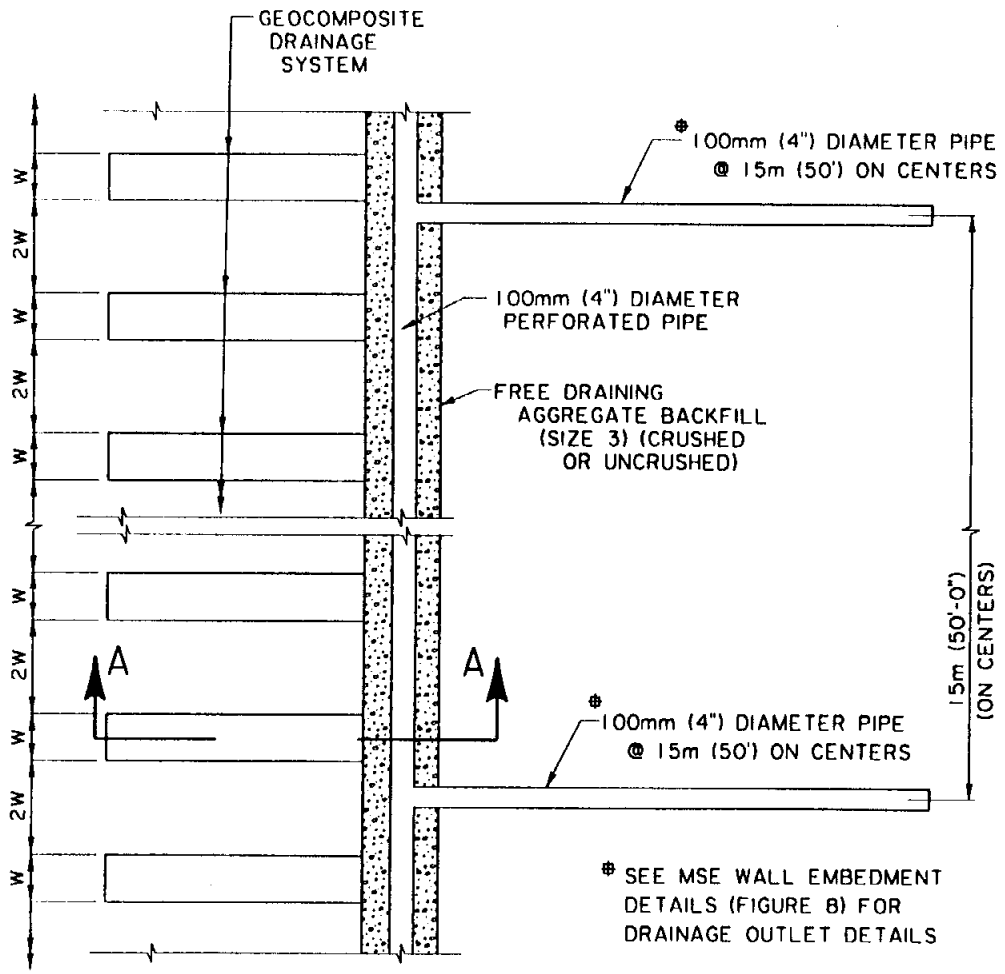
INTERNAL DRAINAGE DETAILS (SHT. 1 OF 2)

MECHANICALLY STABILIZED EARTH WALL

REVISED 07/22/1999

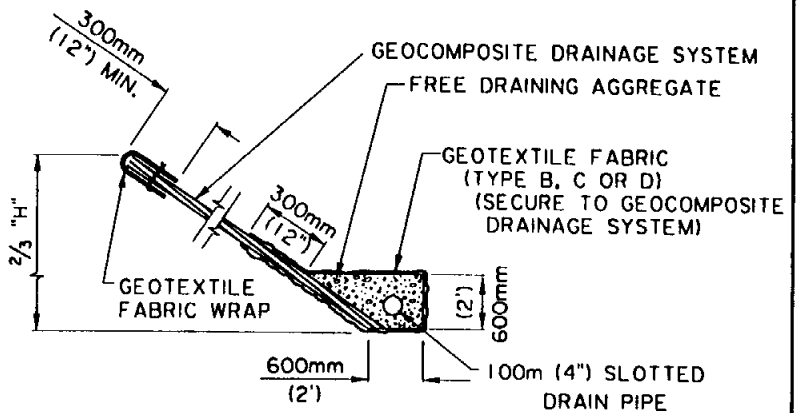
GEDG NO. 8

FIGURE 13



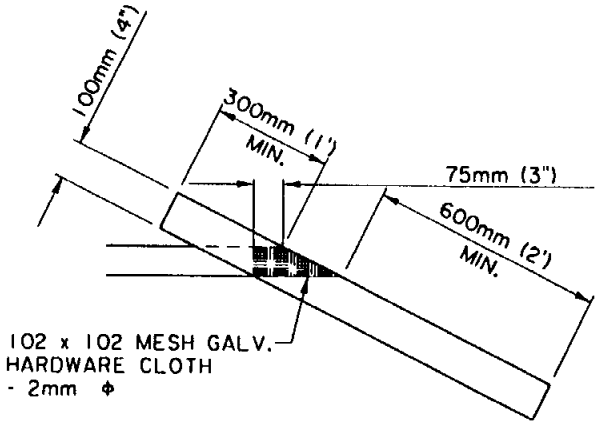
W = WIDTH OF GEOCOMPOSITE DRAINAGE SYSTEM

PLAN VIEW OF GEOCOMPOSITE DRAINAGE SYSTEM



SECTION A - A

"H" = TOTAL HEIGHT OF EMBANKMENT



END TREATMENT FOR DRAIN PIPES

(SHOWING CONCRETE HEADWALL)
(HEADWALL SHALL BE 600mm (2'-0") WIDE)

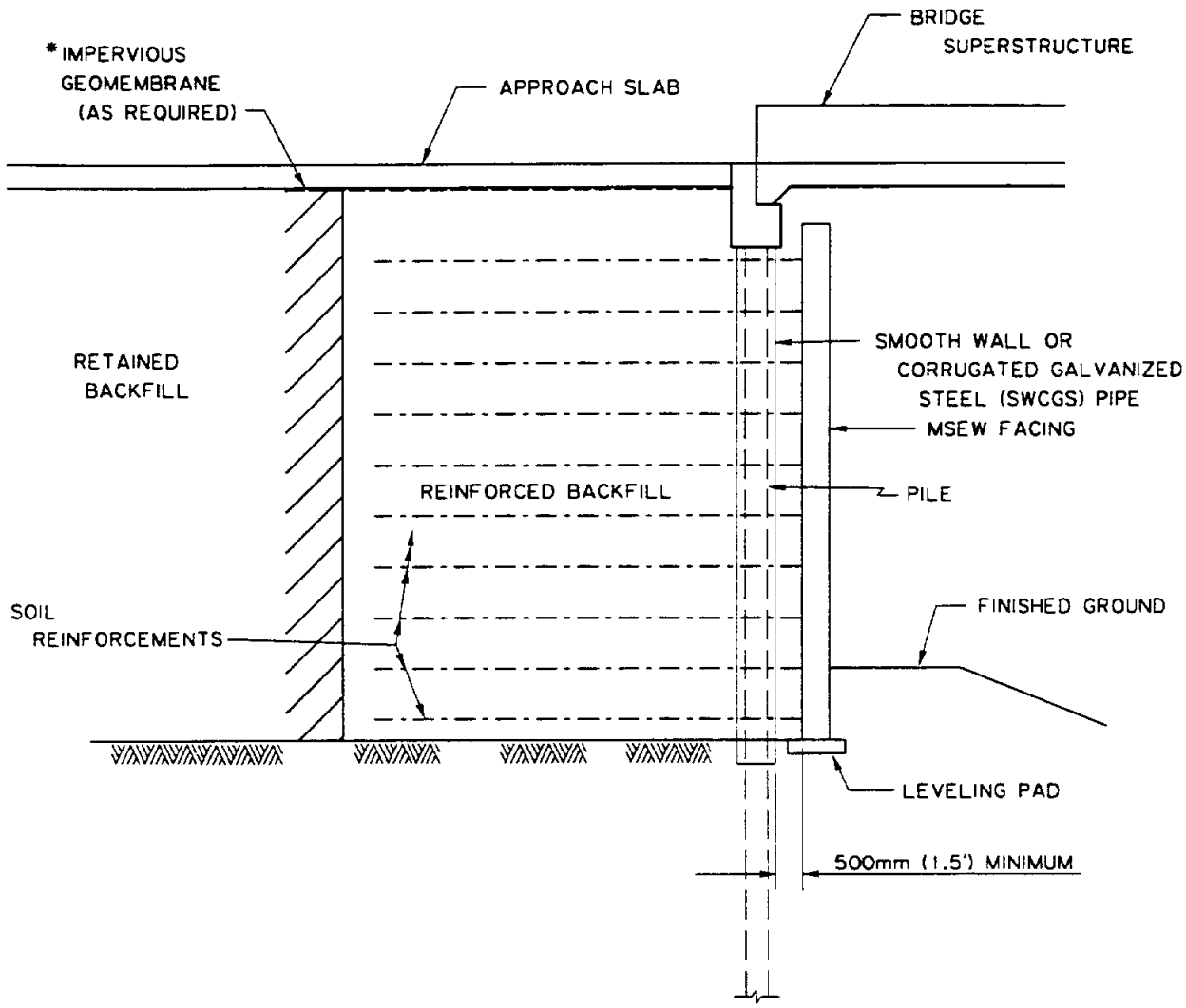
INTERNAL DRAINAGE DETAILS (SHT. 2 OF 2)

MECHANICALLY STABILIZED EARTH WALL

REVISED 04/02/1998

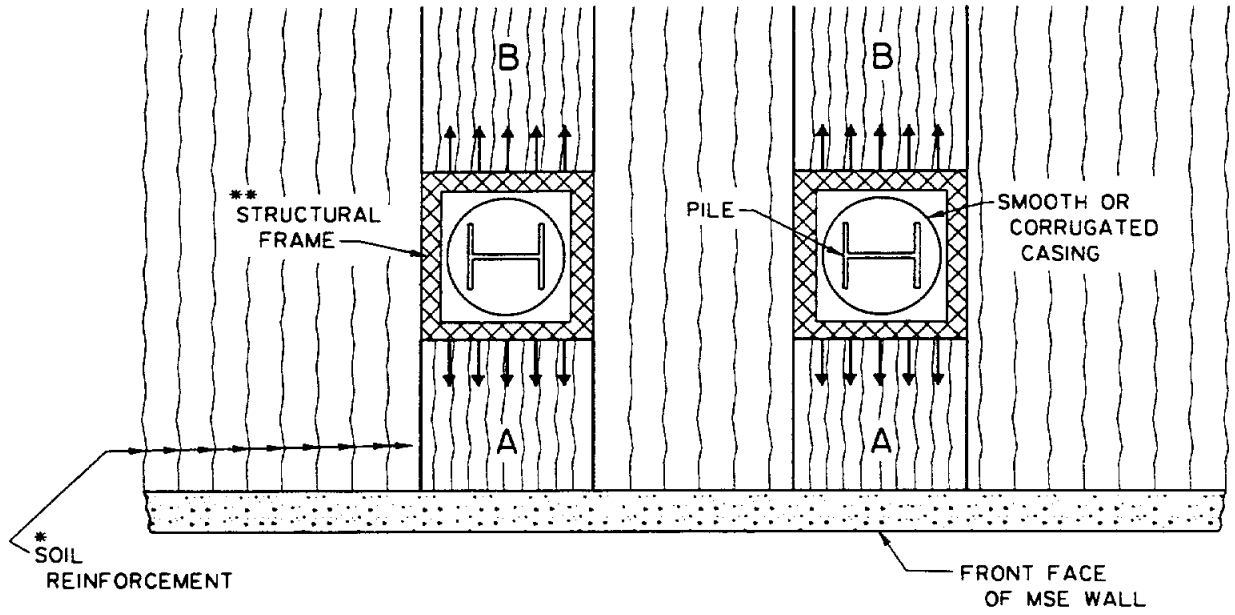
A-13

* IMPERVIOUS GEOMEMBRANE SHALL COVER THE ENTIRE REINFORCED BACKFILL AND SHALL BE INCLUDED IN THE MSEW PAY ITEM.



MSEW OBSTRUCTIONS (ABUTMENT PILING)

MECHANICALLY STABILIZED EARTH WALLS

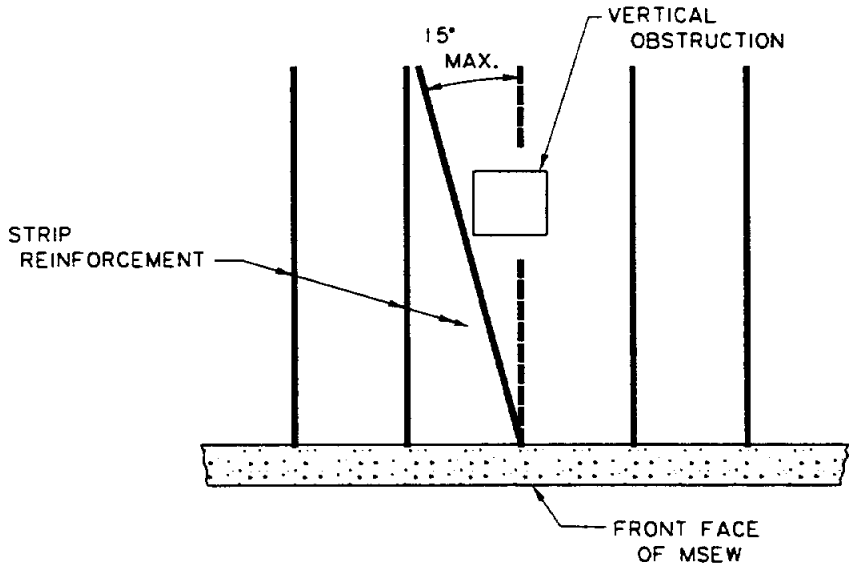


ALTERNATE SOIL REINFORCEMENT DESIGN METHODS

*(1) PROVIDE ADDITIONAL SOIL REINFORCEMENT AT EACH SIDE OF VERTICAL OBSTRUCTION

**(2) PROVIDE A STRUCTURAL FRAME AROUND THE OBSTRUCTION THAT IS CAPABLE OF TRANSFERING THE LOAD FROM THE FRONT REINFORCEMENT (A) TO THE REINFORCEMENT IN THE BACK (B)

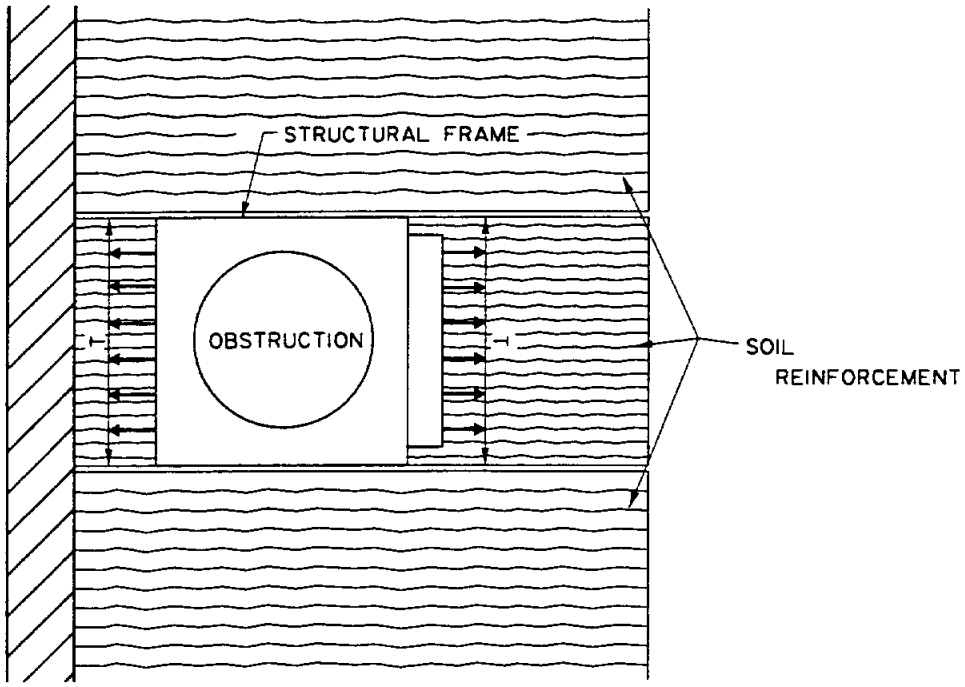
VERTICAL OBSTRUCTION
(PLAN VIEW)



VERTICAL OBSTRUCTION (STRIPS)
(PLAN VIEW)

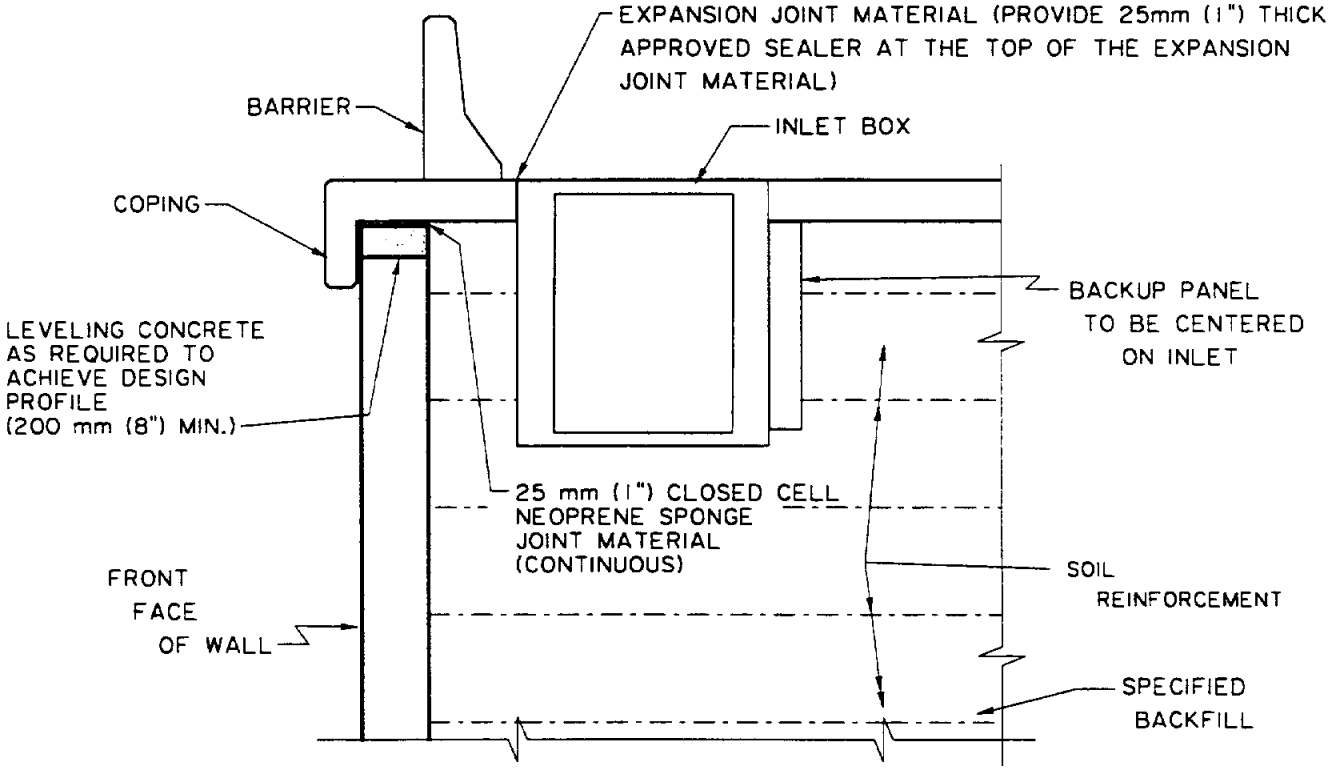
MSEW OBSTRUCTION (VERTICAL)

MECHANICALLY STABILIZED EARTH WALLS



CONCEPTUAL PLAN VIEW

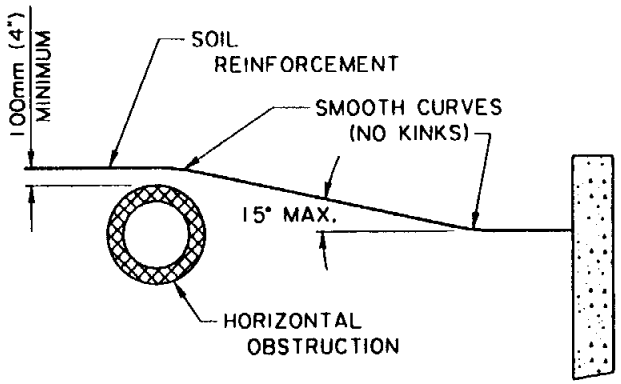
T = TOTAL LOAD WHICH STRUCTURAL FRAME MUST CARRY



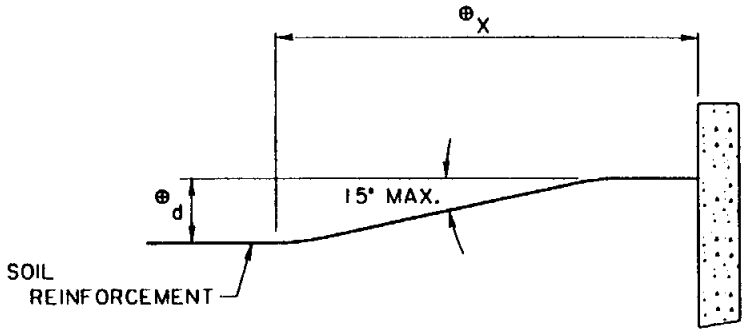
TYPICAL SECTION WITH INLET BEHIND WALL

MSEW OBSTRUCTION (DRAINAGE STRUCTURES)

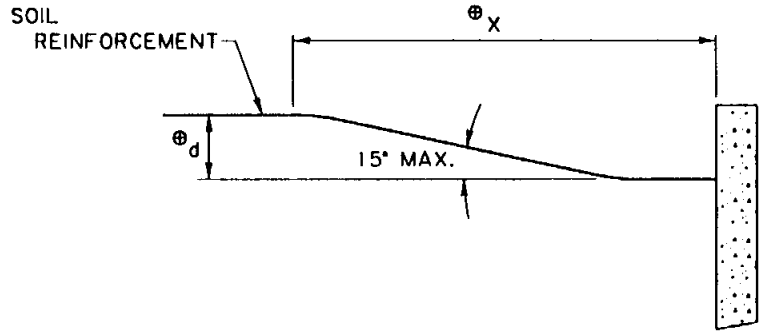
MECHANICALLY STABILIZED EARTH WALLS



HORIZONTAL OBSTRUCTION
(ELEVATION VIEW)



TRANSITION DISTANCE
(UNDER OBSTRUCTION)



TRANSITION DISTANCE
(OVER OBSTRUCTION)

⊕ADDITIONAL DEPTH (d) REQUIRED	⊕REQUIRED MINIMUM DISTANCE (X) TO ACHIEVE SMOOTH BEND
75mm (3")	675mm (27")
150mm (6")	975mm (38")
225mm (9")	1200mm (47")
300mm (12")	1500mm (59")
375mm (15")	1800mm (71")

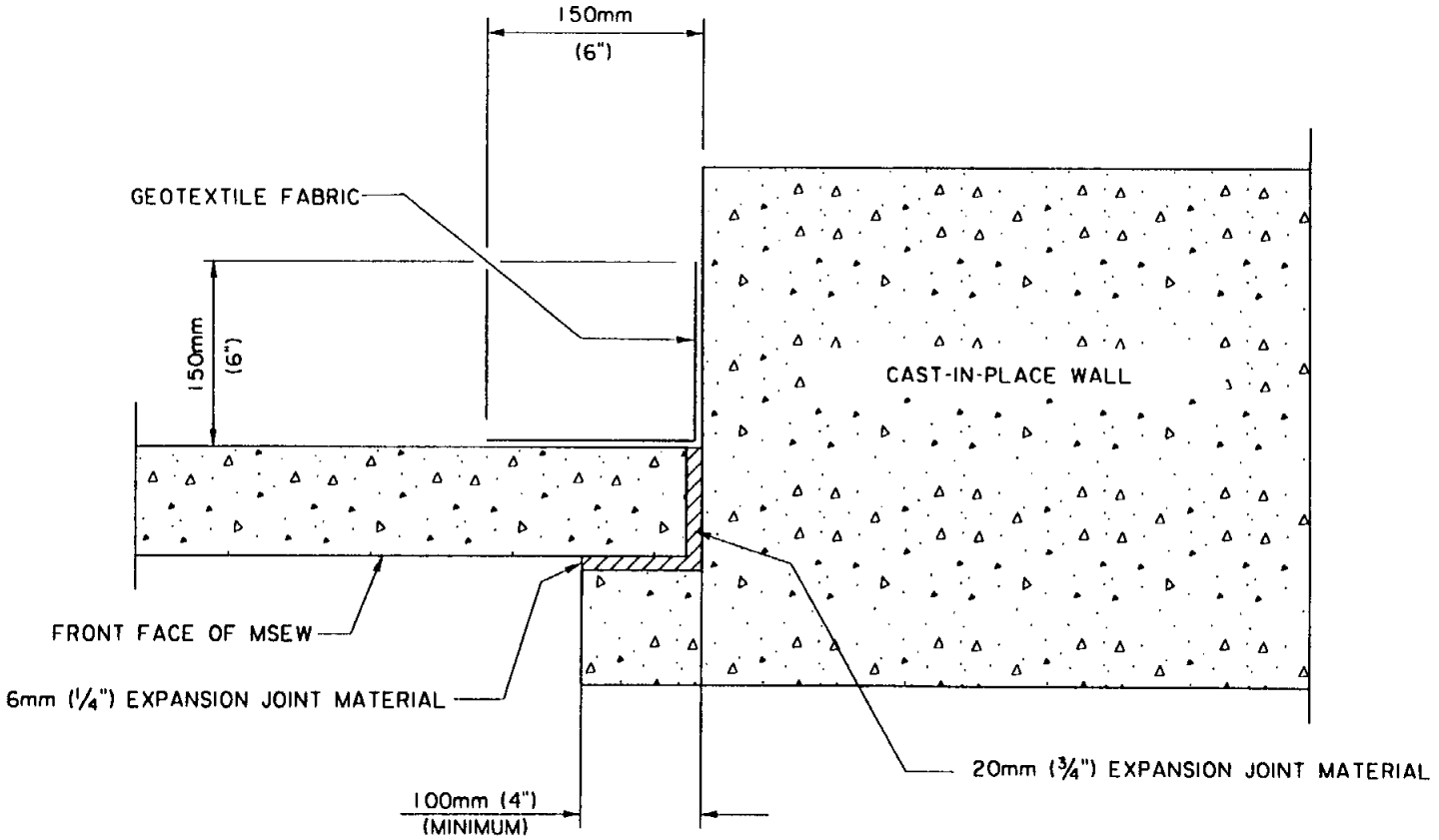
MSEW OBSTRUCTIONS (HORIZONTAL)

MECHANICALLY STABILIZED EARTH WALL

FIGURE 17

GEDG NO. 8

FIGURE 18

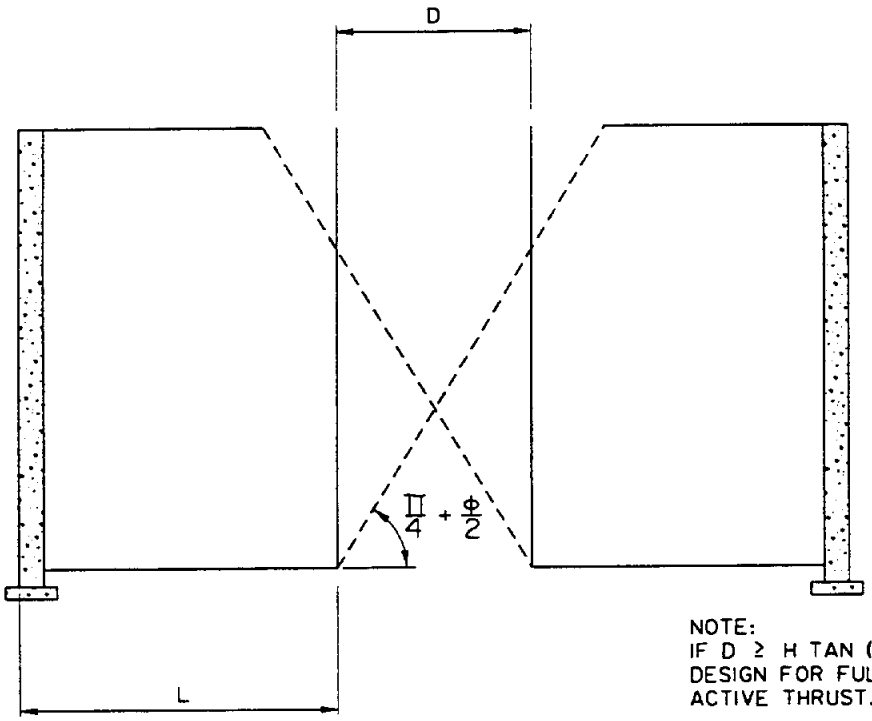


PLAN VIEW WITH MSEW INTERFACE WITH CAST-IN-PLACE WALL

MSEW OBSTRUCTION
(CAST-IN-PLACE STRUCTURES)

MECHANICALLY STABILIZED
EARTH WALL

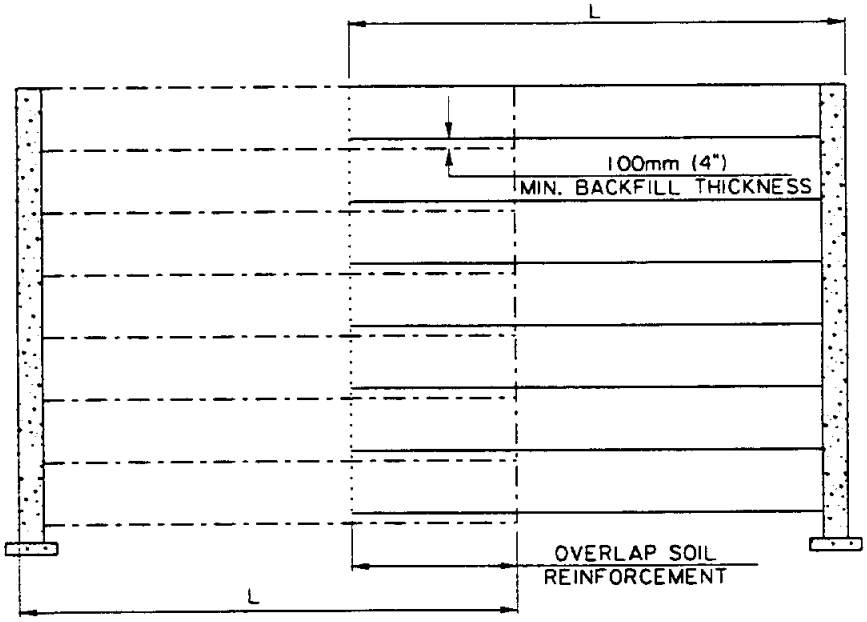
REVISED 04/02/1998



NOTE:
IF $D \geq H \tan(45 - \frac{\Phi}{2})$
DESIGN FOR FULL
ACTIVE THRUST.

IF $D < H \tan(45 - \frac{\Phi}{2})$
ACTIVE THRUST
MAY BE REDUCED.

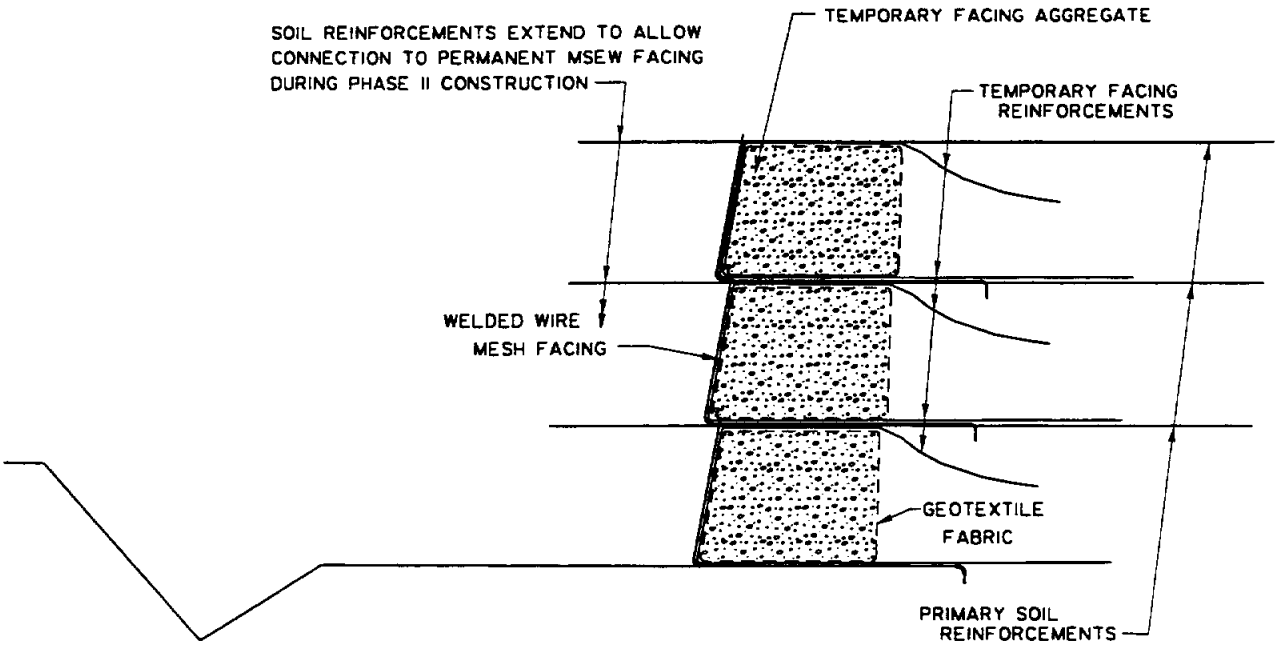
CASE I



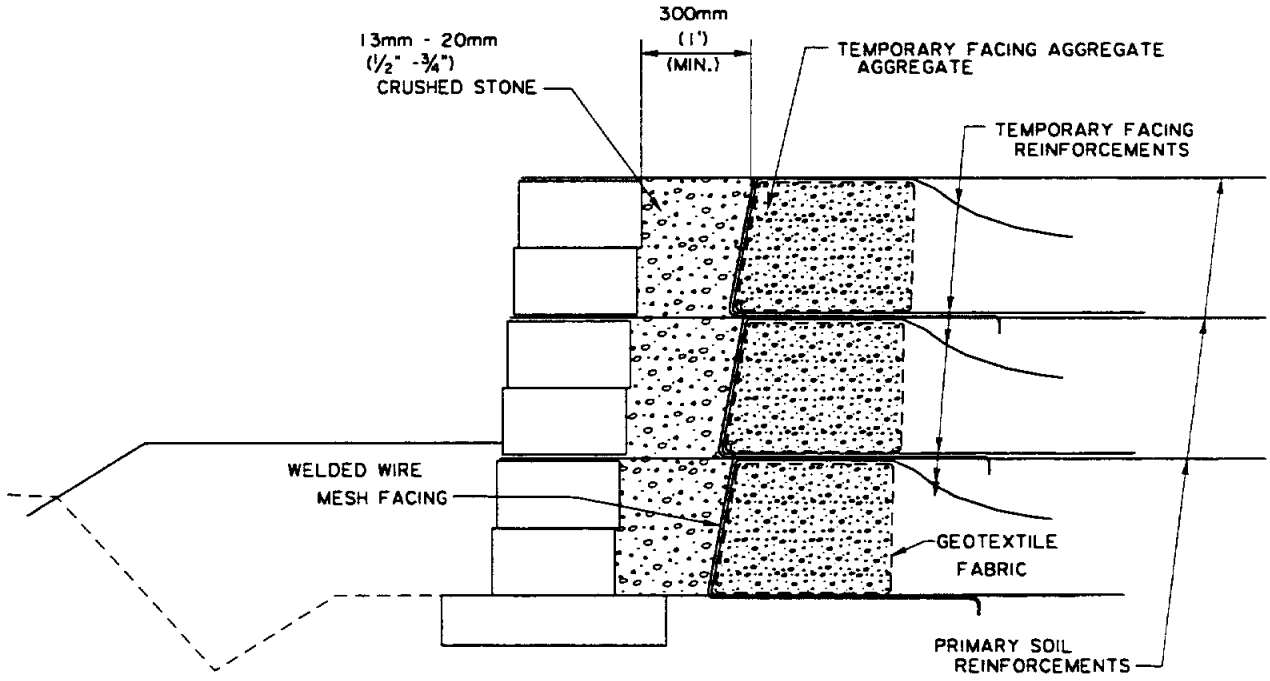
CASE II

MSEW OBSTRUCTIONS (BACK-TO-BACK MSEW)

MECHANICALLY STABILIZED EARTH WALLS



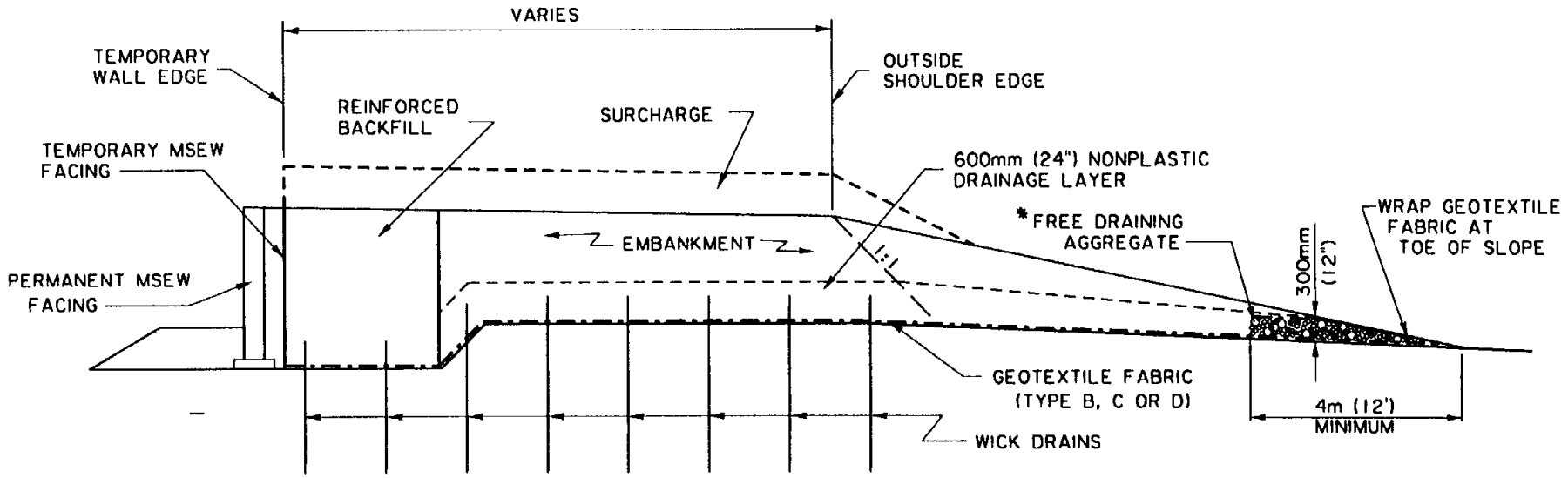
TEMPORARY MSE WALL FACING
PHASE I



PERMANENT MSE WALL FACING
ADDED TO TEMPORARY WALL FACING
PHASE II

MSEW STAGE CONSTRUCTION

MECHANICALLY STABILIZED EARTH WALLS



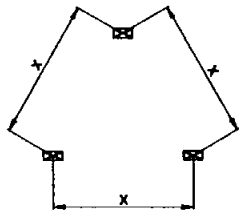
MSE ROADWAY SECTION

NOTES:

1. THE NONPLASTIC DRAINAGE LAYER SHALL CONFORM TO THE SPECIFICATIONS WITH LESS THAN 5% PASSING THE NO. 200 SEIVE.
2. REINFORCED BACKFILL BELOW THE FIRST SOIL REINFORCEMENT LAYER SHALL CONFORM TO THE SPECIAL PROVISIONS WITH LESS THAN 5% PASSING THE NO. 200 SIEVE.
3. THE NONPLASTIC DRAINAGE LAYER AND THE GEOTEXTILE FABRIC SHALL BE PAID FOR UNDER ITEM 203(04).

* FREE DRAINING AGGREGATE SHALL BE 100 PERCENT CRUSHED STONE CONFORMING TO SUBSECTION 1003.01 WITH THE FOLLOWING GRADATION;

SIEVE SIZE	PERCENT PASSING BY WEIGHT
25mm (1")	100
19mm (¾")	90 - 100
9.5mm (⅜")	20 - 55
4750μm (No. 4)	0 - 10
2360μm (No. 8)	0 - 5



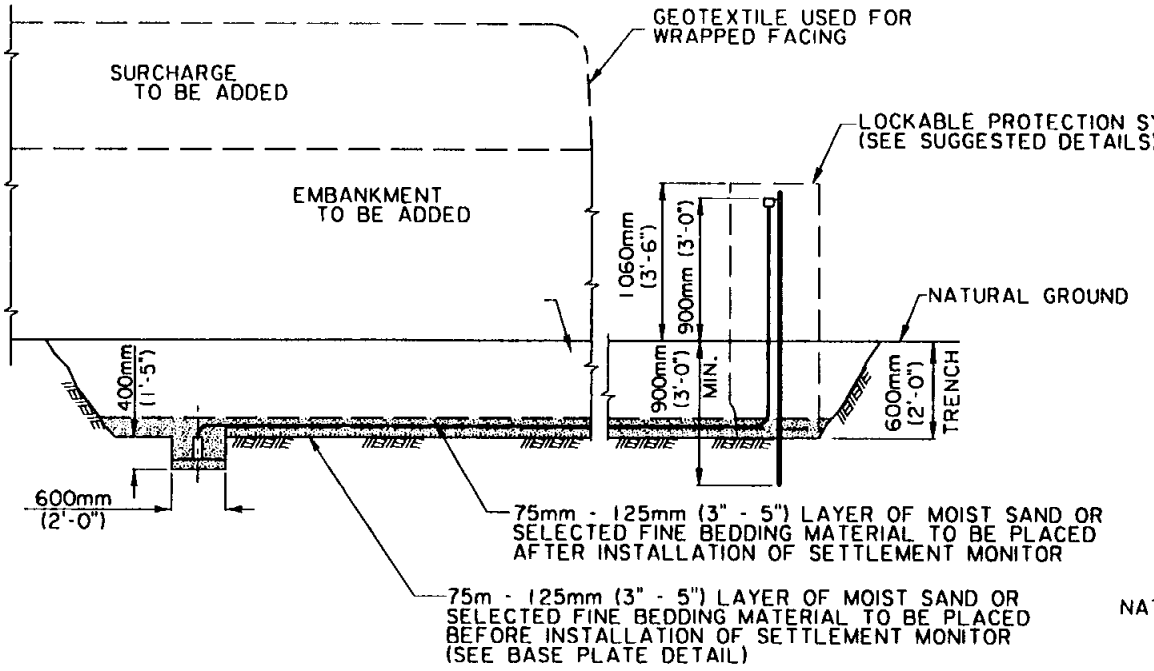
CENTER TO CENTER SPACING
X = CENTER TO CENTER WICK SPACING

MSEW (WICK DRAINS AND SURCHARGE)

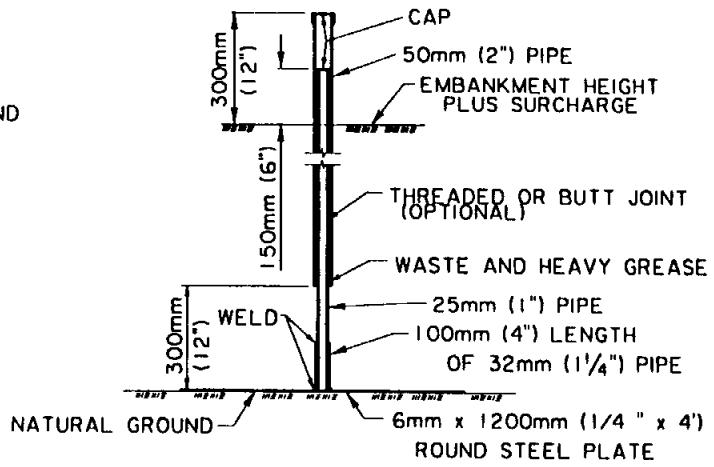
MECHANICALLY STABILIZED EARTH WALL

FIGURE 21

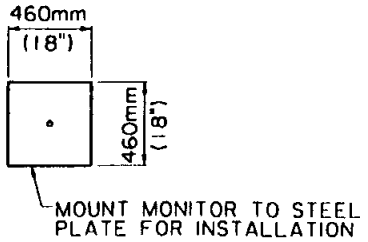
FIGURE 22



DETAIL OF SETTLEMENT MONITOR INSTALLATION



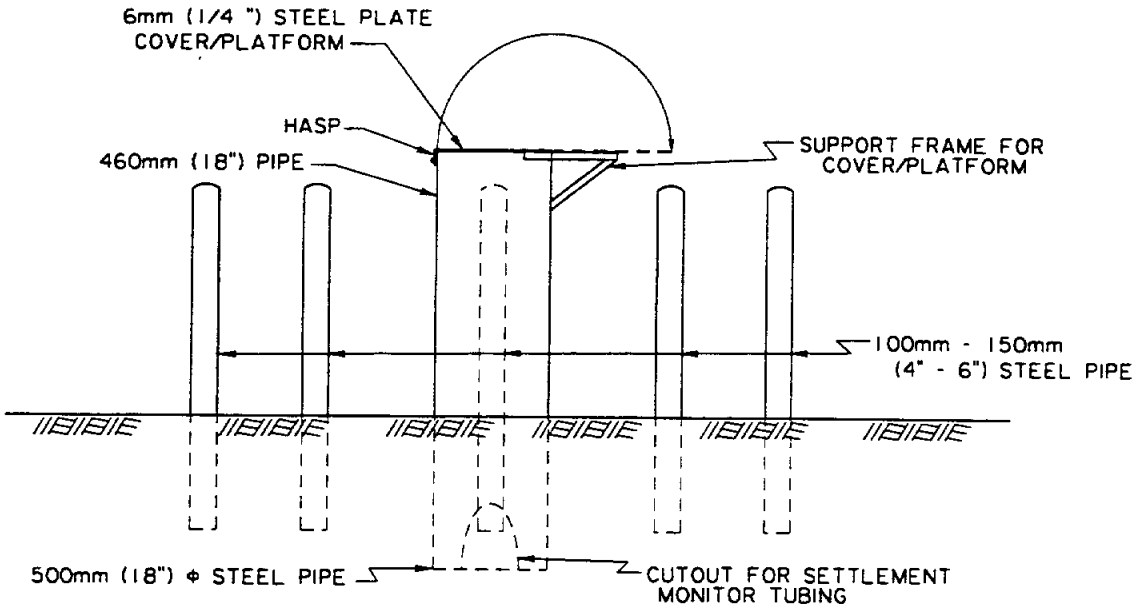
DETAIL OF SETTLEMENT PLATE



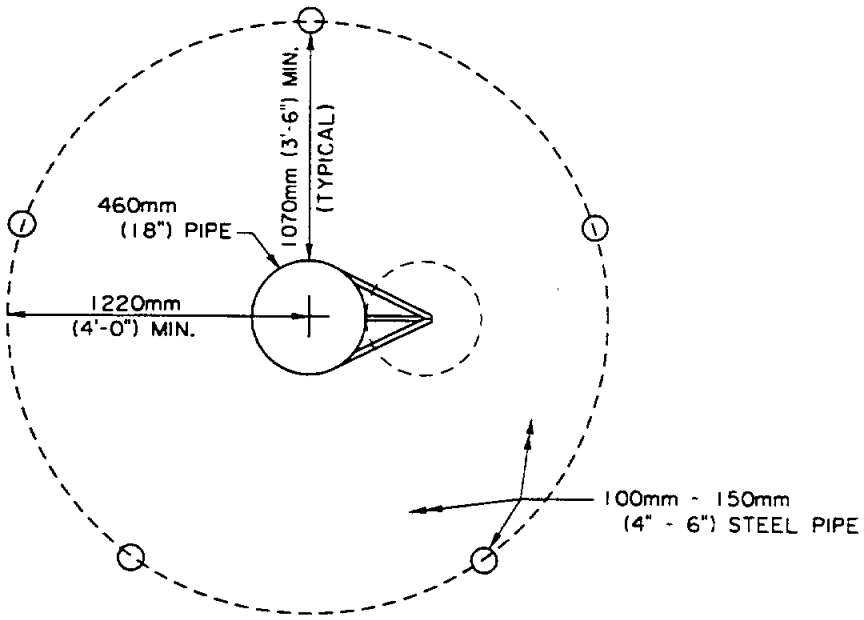
BASE PLATE DETAIL

SETTLEMENT MONITORING

MECHANICALLY STABILIZED EARTH WALL



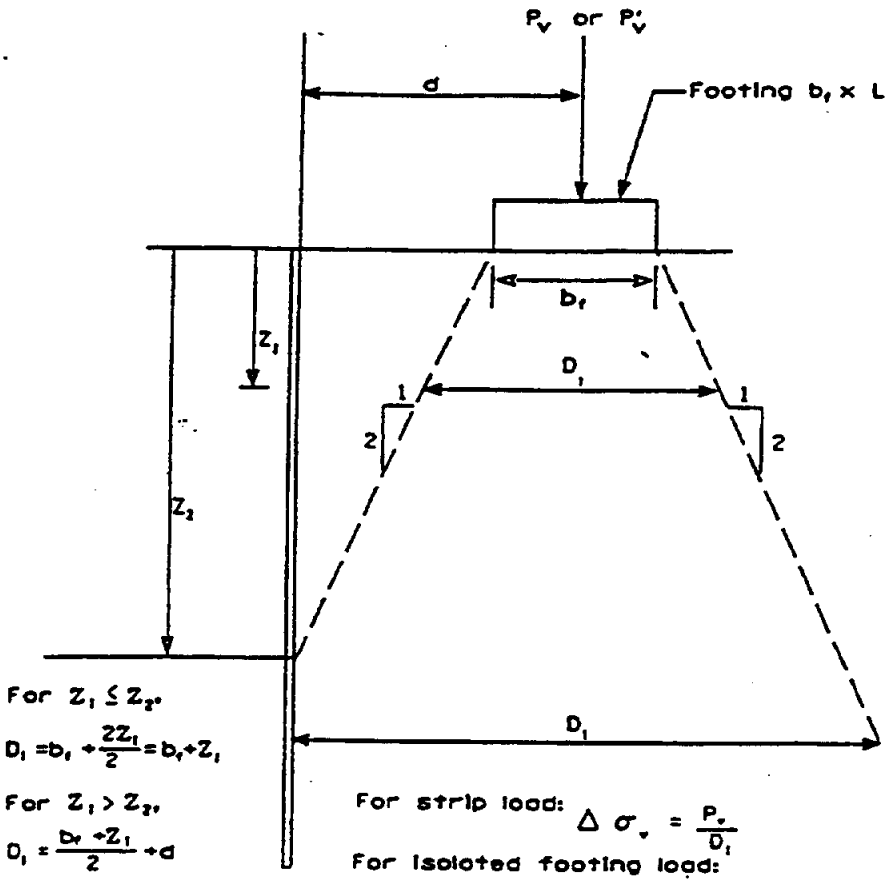
ELEVATION VIEW OF MONITOR PROTECTION SYSTEM



PLAN VIEW OF MONITOR PROTECTION SYSTEM

SETTLEMENT MONITORING PROTECTION

MECHANICALLY STABILIZED EARTH WALLS



For $Z_1 \leq Z_2$,

$$D_1 = b_f + \frac{2Z_1}{2} = b_f + Z_1$$

For $Z_1 > Z_2$,

$$D_1 = \frac{b_f + Z_1}{2} + d$$

For strip load: $\Delta \sigma_v = \frac{P_v}{D_1}$

For isolated footing load:

$$\Delta \sigma_v = \frac{P_v'}{D_1(L + Z_1)}$$

For point load:

$$\Delta \sigma_v = \frac{P_v'}{D_1^2} \text{ with } b_f = 0$$

Where: D_1 = Effective width of applied load at any depth, calculated as shown above

b_f = Width of applied load. For footings which are eccentrically loaded (e.g., bridge abutment footings), set b_f equal to the equivalent footing width B' by reducing it by 2e', where e' is the eccentricity of the footing load (i.e., $b_f - 2e'$).

L = Length of footing

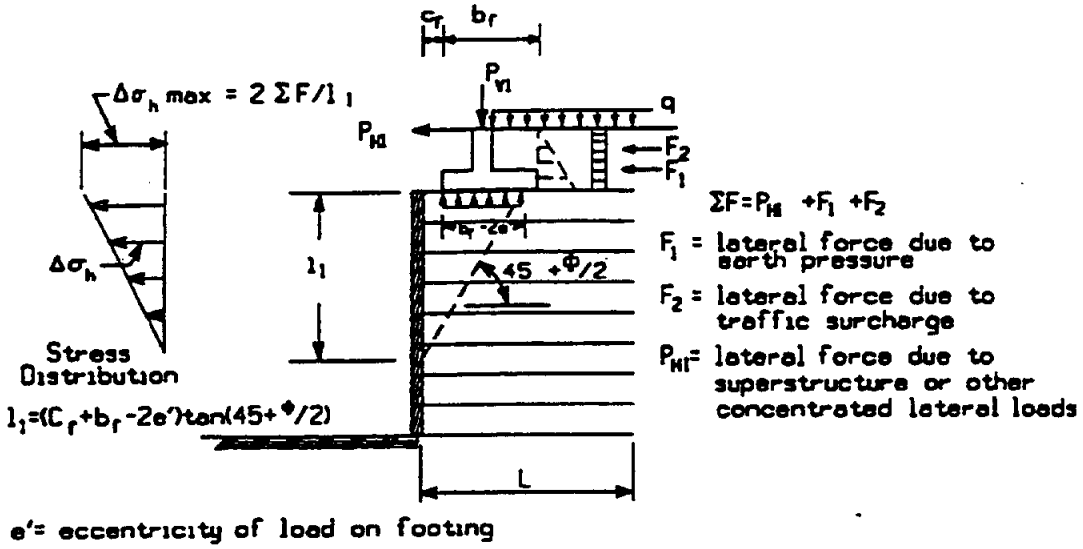
P_v = Load per linear meter (foot) of strip footing

P_v' = Load on isolated rectangular footing or point load

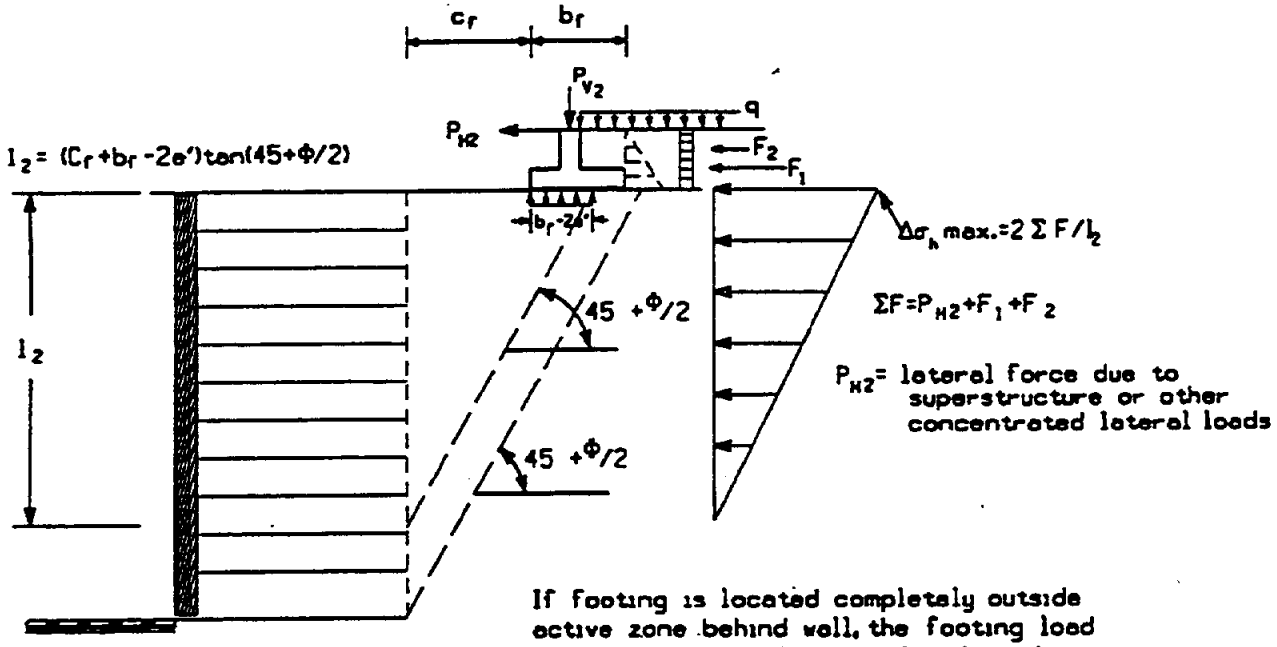
Z_2 = depth where effective width intersects back of wall face = 2d - b

Assume the increased vertical stress due to the surcharge load has no influence on stresses used to evaluate internal stability if the surcharge load is located behind the reinforced soil mass. For external stability, assume the surcharge has no influence if it is located outside th active zone behind the wall.

DISTRIBUTION OF STRESS FROM CONCENTRATED VERTICAL LOAD Pv FOR INTERNAL AND EXTERNAL STABILITY



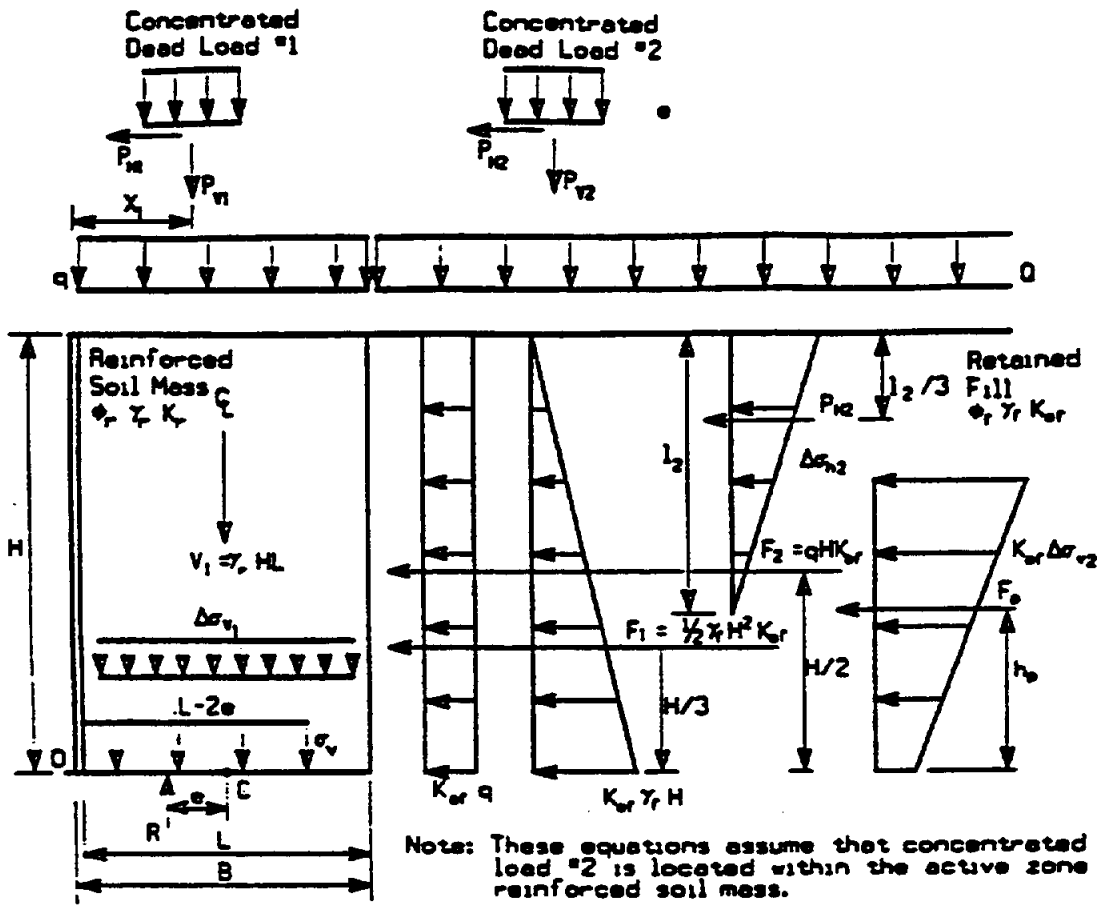
a. Distribution of Stress for Internal Stability Calculations.



b. Distribution of Stress for External Stability Calculations.

DISTRIBUTION OF STRESSES FROM CONCENTRATED HORIZONTAL LOADS

MECHANICALLY STABILIZED EARTH WALLS



Note: These equations assume that concentrated dead load #2 is located within the active zone behind the reinforced soil mass.

For External Stability, Summing Moments about Point O:

$$FS_{OT} = \frac{V_1 (L/2) + P_{V1} (X_1) + qL (L/2)}{F_1 (H/3) + F_2 (H/2) + P_{H1}(H) + P_{H2}(H-l_2/3) + F_p h_p}$$

$$FS_{SL} = \frac{(V_1 + qL + P_{V1}) \operatorname{Tan} \phi}{F_1 + F_2 + P_{H1} + P_{H2} + F_p}$$

For Bearing Calculations, Summing Moments about Point C:

$$e = \frac{F_1 (H/3) + F_2 (H/2) + P_{H2} (H-l_2/3) + F_p h_p + P_{H1} H \pm P_{V1} (L/2 - X_1)}{\gamma_r HL + qL + P_{V1}}$$

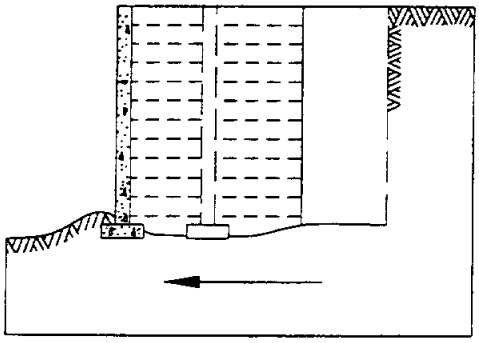
$$\sigma_v = \frac{V_1 + qL}{L-2e} + \Delta\sigma_{V1}$$

Note: For relatively thick facing elements (e.g., segmental concrete facing blocks) it may be desirable to include the facing dimensions and weight in sliding, overturning and bearing capacity calculations (i.e., use "B" in lieu of "L").

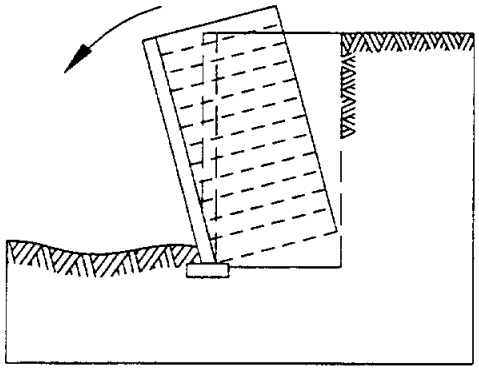
Note: P_{V1}, P_{H1}, P_{V2}, P_{H2}, $\Delta\sigma_{V1}$, $\Delta\sigma_{h2}$, $\Delta\sigma_{V2}$, and l_2 are as determined from Figures 5.8.12.1A and 5.8.12.1B and F_p results from P_{V2} (i.e., $K\Delta\sigma_{V2}$ from figure 5.8.12.1A). H is the total wall height at the face.

SUPERPOSITION OF CONCENTRATED DEAD LOADS FOR EXTERNAL STABILITY EVALUATION

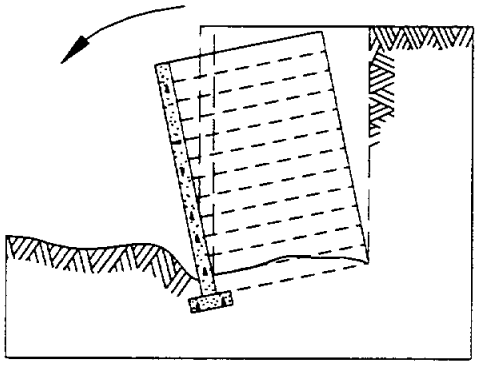
MECHANICALLY STABILIZED EARTH WALLS



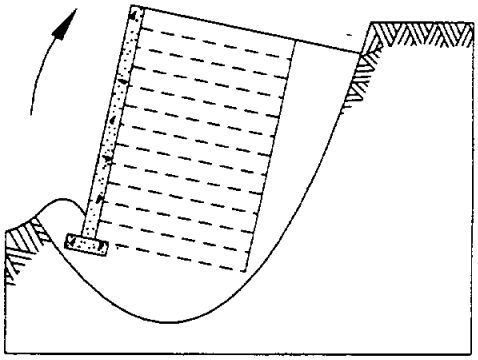
(a) SLIDING



(b) OVERTURNING

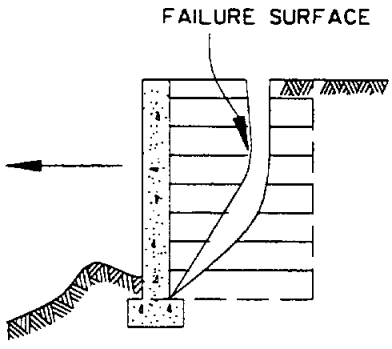


(c) BEARING CAPACITY

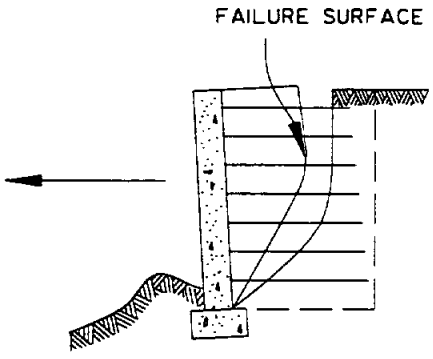


(d) GLOBAL STABILITY (DEEP SEATED)

EXTERNAL STABILITY
MECHANISMS OF FAILURE IN MSEW
(DETAIL A)



(a) REINFORCEMENT RUPTURE

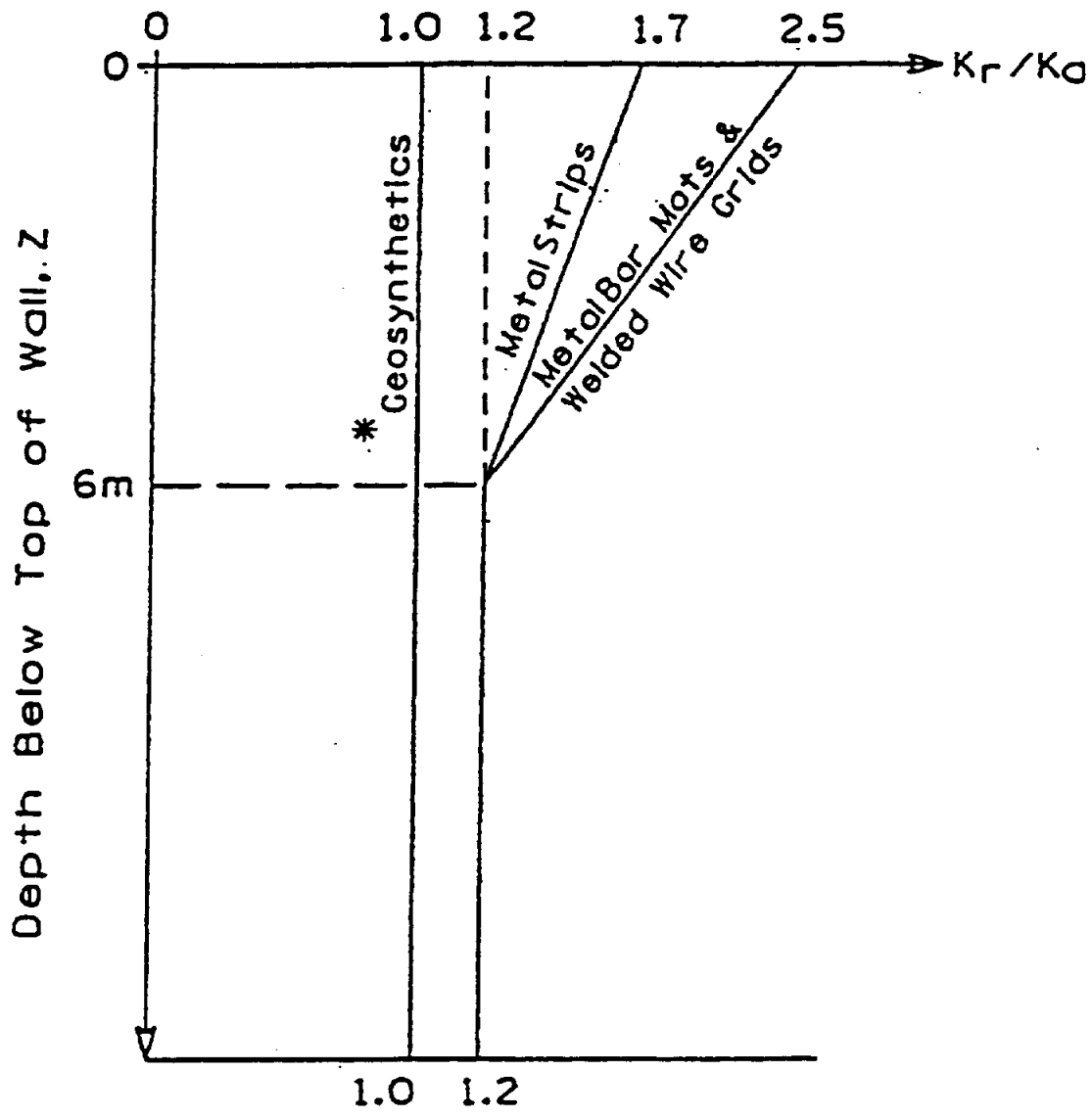


(b) REINFORCEMENT PULLOUT FAILURE

MECHANISMS OF
INTERNAL FAILURE IN MSEW
(DETAIL B)

MSEW FAILURE MODES

MECHANICALLY STABILIZED
EARTH WALLS

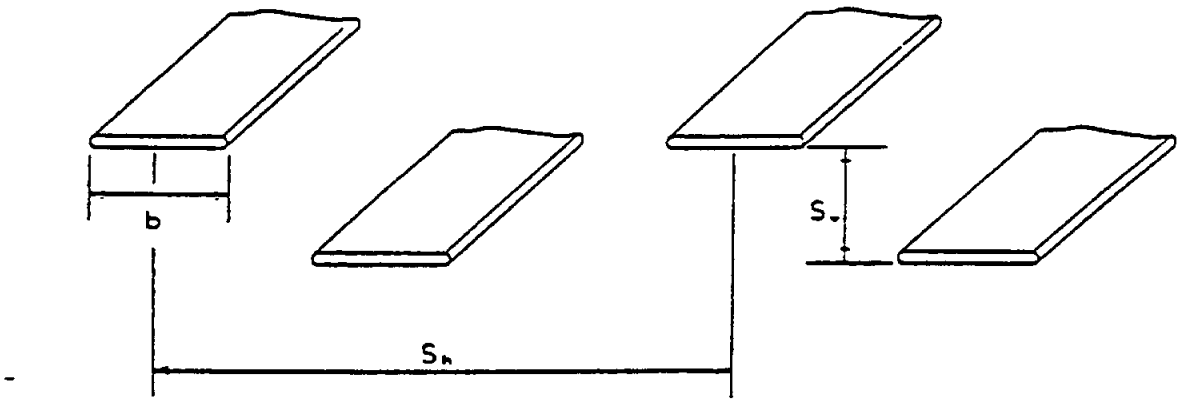


*Does not include polymer strip reinforcement

STRESS RATIO (K_r/K_a) DESIGN CHART

MECHANICALLY STABILIZED EARTH WALLS

Discontinuous Geosynthetic Sheets:



Continuous Geosynthetic reinforcement sheets:

$$T_{max} \leq T_a R_c = \frac{T_{al} \; R_c}{(FS)} = \frac{T_{ult} \; R_c}{(FS)(RF)}$$ (See Article 5.8.6.2.2)

Where T_a = allowable long-term tensile strength of reinforcement (strength/unit reinforcement width)

T_{al} = long-term tensile strength required to prevent rupture (strength/unit reinforcement width)

T_{ult} = wide width tensile strength (strength/unit reinforcement width)

R_c = reinforcement coverage ratio = $\frac{b}{S_h}$

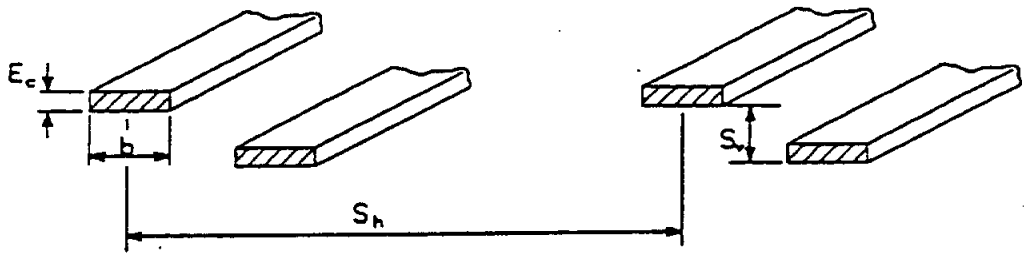
Use R_c = 1 for continuous geosynthetic sheets (i.e., S_h = b = 1 unit width)

FS = safety factor (see Article 5.8.6.2)

RF = combined reduction factor to account for longterm degradation (see Article 5.8.6.1.2).

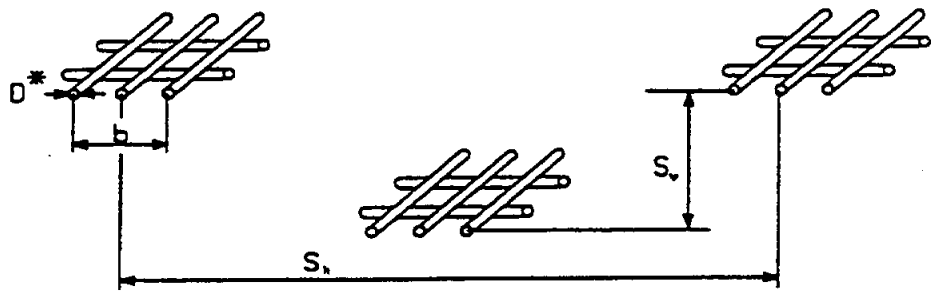
PARAMETERS FOR GEOSYNTHETIC REINFORCEMENT STRENGTH CALCULATIONS

MECHANICALLY STABILIZED EARTH WALLS



$A_c = b E_c$

E_c = strip thickness corrected for corrosion loss.



$$A_c = (\text{No. of longitudinal bars}) \cdot \pi \frac{D^{*2}}{4}$$

D^* = diameter of bar or wire corrected for corrosion loss.

b = unit width of reinforcement (if reinforcement is continuous count number of bars for reinforcement width of 1 unit).

$$T_{max} \leq T_a R_c = \frac{FS\ A_c\ F_y\ R_c}{b}$$

Where T_a = allowable long-term tensile strength of reinforcement (strength/unit reinforcement width)

FS = factor of safety

F_y = yield strength of steel

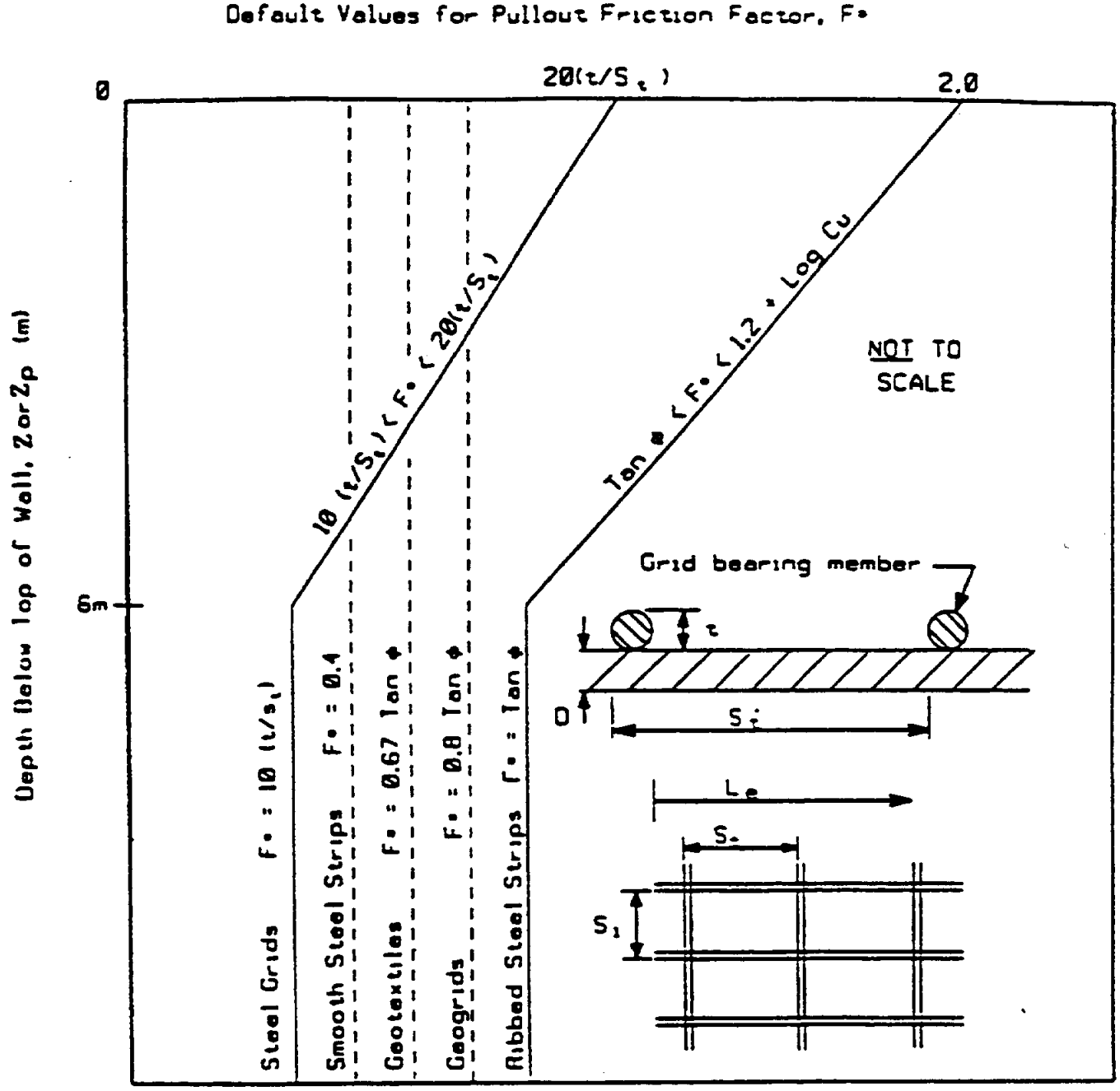
R_c = reinforcement coverage ratio = $\frac{b}{S_h}$

Use R_c = 1 for continuous reinforcement (i.e., S_h = b = 1 unit width).

T_{max} = maximum load applied to reinforcement (load/unit wall width).

STRENGTH DESIGN PARAMETERS
FOR INEXTENSIBLE REINFORCEMENT

MECHANICALLY STABILIZED
EARTH WALLS



DEFAULT PULLOUT FRICTION FACTOR (F*)

MECHANICALLY STABILIZED EARTH WALLS

APPENDIX B

SAMPLE LETTERS

MSEW SAMPLE NOTIFICATION LETTER
(Pre-Qualified System Based Contracting Method)

State Project No. _____ (Construction)
State Project No. _____ (Engineering)
FAP No. _____
_____
_____

Attn: _____

Gentlemen:

The Louisiana Department of Transportation is anticipating letting the captioned project in _____.

The enclosed information is being transmitted for your information and bid preparation. If your company has any innovative methods or designs for this project, they should be submitted before for our review.

We are enclosing the following material for your use:

- Preliminary MSEW Control plans
- Roadway/Bridge plans
- Soil Borings

Your design must conform strictly with the above information.

The MSEW design criteria and minimum safety factors are shown in Attachment 1.

Your acknowledgement of receipt of this package and applicability of your wall for this/these site(s) is appreciated. In the event that you do not wish to participate in this project, the enclosed material may be discarded. Failure to participate at this time will make your MSEW system ineligible for participation (including Value Engineering proposals) in this project.

If there are any questions, please advise.

PROJECT COORDINATOR

Attachments
cc: Mr. J. B. Esnard, Jr.

Attachment 1

Design Life:
75 years (Permanent MSEW Structure)

Estimated Settlement:
Maximum Differential Settlement = 1/200 (*MSEW identification*)
Maximum Settlement @ *(Sta. 0+000.0)* ≈ 75 mm (3 inches)

Reinforced Backfill Material:
Granular Backfill
Internal Friction Angle, $\phi = 30°$
Wet Unit Weight = 18.1 kN/m^3 (115 pcf)

Retained Backfill:
Internal Friction Angle, $\phi = 30°$
Wet Unit Weight = 18.9 kN/m^3 (120 pcf)

External Stability

Global Stability Safety Factor, FS_{Global}	= 1.3
Sliding Stability Safety Factor, $FS_{Sliding}$	= 1.5
Overturning Safety Factor, $FS_{Overturning}$	= 2.0
Eccentricity	≤ L/6
Bearing Capacity Safety Factor, $FS_{Bearing}$	= 2.5

Internal Stability:

Pullout Safety Factor, FS_{PO}	= 1.5

MSEW SAMPLE INVITATION LETTER
(Pre-Designed System Based Contracting Method)

State Project No. _____ (Construction)
State Project No. _____ (Engineering)
FAP No. _____
_____
_____

Attn: _____

Gentlemen:

The Louisiana Department of Transportation extends to your company an invitation to participate in alternate designs for the MSEW structures to be included in the captioned project.

Submittals: Your participation will involve submitting three (3) sets of prints of your final design for our review, and upon notification of our acceptance, the submittal of drawings on polyester film material for inclusion in the final plan assembly. The final design plans shall be developed in accordance with the Department's *Geotechnical Engineering Design Guide No. 8, Mechanically Stabilized Earth Wall (MSEW) Design Guide.*

The captioned project has been scheduled for letting in _____; therefore, the final plans and design calculations shall be submitted not later than _____and the final tracings submitted not later than _____ in order to meet this schedule.

Your design must conform strictly to the following information:

- Preliminary MSEW Control plans
- Roadway/Bridge plans
- Soil Borings

Design Scope: The MSEW structures shall be considered gravity walls and shall be designed for external and internal stability of the reinforced soil mass. The Department will be responsible for the external stability, which shall consist of checking global stability for deep seated failures, the sliding stability of the reinforced soil mass, overturning, settlement (magnitude and rate), and bearing of the reinforced soil mass. The external stability of the MSEW structure, with appropriate safety factors, is satisfied with the minimum base width required, B_{req}, that is specified in the Preliminary MSEW Control Plans.

The MSEW system supplier shall be responsible for the internal stability design. The MSEW system supplier's design shall consist of determining the required soil reinforcement length and strength, connection strength, and facing stability in accordance with the plans and the Department's *Geotechnical Engineering Design Guide No. 8, Mechanically Stabilized Earth Wall (MSEW) Design Guide.*

The MSEW system supplier's design shall specify the minimum required wall face batter to limit the amount of horizontal movements resulting from the outward rotation of the wall as a result of the development of internal equilibrium between the loads applied to the wall and the internal structure of the wall.

General Design Methodology: The design of permanent and temporary MSEW shall be in accordance with the *Department's Geotechnical Engineering Design Guide No. 8, Mechanically Stabilized Earth Wall (MSEW) Design Guide*, and the 1997 interim or more current edition of the AASHTO "Standard Specifications for Highway Bridges." The Department will not accept designs based on methodology other than required by these specifications.

Design Calculations: The MSEW system supplier shall furnish the Department with a complete set of design calculations for internal stability. Computer generated designs used by the contractor shall be reviewed and approved by the Department. Verification that the computer program's design methodology meets the requirements provided herein, and the accuracy of the computer generated solution, shall be made by having the contractor submit a copy of the computer program and a complete, legible, hand calculation check for the most critical geometry and loading condition that will govern the design of the MSEW structure. The determination of all loading conditions shall be fully documented with all design calculations and assumptions. Submitted calculations (including computer runs) shall include all load cases that exist at final completion and during construction for any required surcharges, hydraulic conditions, live loads, and loading combinations. A summary of the design computations indicating geometry, loadings, and analysis results shall be furnished with the design calculations.

Design Criteria: The MSEW design criteria and minimum safety factors are shown in Attachment 1.

Certification Package: The MSEW system supplier shall submit a Certification Package prepared by the MSEW supplier or MSEW component manufacturer.

The MSEW Certification Package shall include a Certificate of Compliance that certifies the following (as applicable to the MSEW system):

1. The ultimate tensile strength, T_{ULT}, (MARV) for extensible soil reinforcements (geosynthetics).
2. The allowable tensile load, T_a, multiplied by the reinforcement coverage ratio, Rc, meets or exceeds the MSE block wall's maximum applied tensile load, T_{max}.
3. The allowable connection load between the modular concrete block facing and the soil reinforcement, T_{ac}, multiplied by the reinforcement coverage ratio, R_c, meets or exceeds the MSE block wall's maximum applied load to the soil reinforcement connection, T_o, at the wall facing.

4. The geosynthetic's pullout coefficients (**F***, α) meet or exceed the MSEW's required design pullout coefficients.

The certified values shall be documented as indicated in the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide.* In case of a dispute over the validity of values, testing shall be performed by DOTD. For tests unable to be performed by DOTD, the engineer will require the contractor to supply test data from a DOTD approved independent laboratory to support the certified values. These additional tests shall be performed at no additional cost to the Department. If in the opinion of the engineer, the required documentation is not provided for individual reduction factors (RF) or pullout coefficients (**F***, α), default values for these design parameters shall be used in accordance with the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide.* If the MSEW supplier chooses to use default values, the Certificate of Compliance shall indicate this.

Your acknowledgement of this invitation and acceptance/rejection will be appreciated. In case of non-acceptance, the enclosed material may be discarded. If your MSEW design is rejected or you fail to acknowledge this letter, your MSEW system will be ineligible to be considered for participation (including Value Engineering proposals) in this project.

If there are any questions, please advise.

PROJECT COORDINATOR

Attachments
cc: Mr. J. B. Esnard, Jr.

Attachment 1

Design Life:

75 years (Permanent MSEW Structure)

Estimated Settlement:

Maximum Differential Settlement = 1/200 (*MSEW identification*)
Maximum Settlement @ *(Sta. 0+000.0)* ≈ 75 mm (3 inches)

Reinforced Backfill Material:

Granular Backfill
Internal Friction Angle, $\phi = 30°$
Wet Unit Weight = 18.1 kN/m^3 (115 pcf)

Retained Backfill:

Internal Friction Angle, $\phi = 30°$
Wet Unit Weight = 18.9 kN/m^3 (120 pcf)

External Stability

Global Stability Safety Factor, FS_{Global}	= 1.3
Sliding Stability Safety Factor, $FS_{Sliding}$	= 1.5
Overturning Safety Factor, $FS_{Overturning}$	= 2.0
Eccentricity	≤ L/6
Bearing Capacity Safety Factor, $FS_{Bearing}$	= 2.5

Internal Stability:

Pullout Safety Factor, FS_{PO}	= 1.5

APPENDIX C

SPECIAL PROVISIONS

MSEW STRUCTURAL EXCAVATION AND BACKFILL

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

GEDG NO. 8 (10/01/1999)

SAMPLE SPECIFICATION

STATE PROJECT NO. 000-00-0000
SPECIAL PROVISIONS
(Required for All Contracting Methods)

ITEM S-000, MSEW STRUCTURAL EXCAVATION AND BACKFILL: This item consists of structural excavation and backfill below the original ground line to facilitate the placement of the reinforced backfill in accordance with the Mechanically Stabilized Earth Wall (MSEW) special provisions. This item shall include the furnishing and subsequent removal of any retaining systems and dewatering systems necessary for execution of the work. This item shall also include the disposal of all excavated materials below the original ground elevation to the final grading line.

WALL EXCAVATION

MSEW excavation shall be in accordance with the requirements of Section 802.

FOUNDATION PREPARATION

The foundation for the MSEW structure shall be graded level for a width equal to or exceeding the length of the soil reinforcements plus 500 mm (1 foot) or as shown in the plans. Prior to the MSEW construction, the foundation shall be compacted with a smooth vibratory wheel roller weighing a minimum of 7.2 Mg (8 tons) for at least five passes or as directed by the engineer. Any foundation soils found to be unstable by the engineer shall be removed and replaced with backfill material and compacted to 95 percent of the maximum density as determined by DOTD TR 418.

MSEW BACKFILL

All MSEW backfilling operations including placement of geotextile fabrics, leveling pad, MSEW facing, select reinforced backfill, soil reinforcement shall be performed in accordance with the Mechanically Stabilized Earth Wall special provisions.

MEASUREMENT AND PAYMENT

MSEW Structural Excavation and Backfill shall be paid for at the contract lump sum price. Payment for this item will include all materials, labor, equipment, and other incidentals required for completion of this work. This item includes excavating, disposing, and backfilling of materials below the original ground line in accordance with the plans and this specification. Materials required during the backfilling operations to construct the MSEW structure such as geotextile fabric, leveling pad, MSEW facing units, soil reinforcement, etc., shall be furnished and paid for under the Mechanically Stabilized Earth Wall (MSEW) item.

Payment will be made under:

Item S-000, MSEW Structural Excavation and Backfill, per lump sum

APPENDIX D

SPECIAL PROVISIONS

MECHANICALLY STABILIZED EARTH WALL (MSEW) (PRE-QUALIFIED SYSTEM BASED)

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

GEDG NO. 8 (10/01/1999)

STATE PROJECT NO. 000-00-0000
SPECIAL PROVISIONS
(Pre-Qualified System Based Contracting)

ITEM S-000(A), MECHANICALLY STABILIZED EARTH WALL (MSEW)

MSEW SUBMITTALS

MSEW DESIGN

- **(a)** Design Scope
- **(b)** General Design Methodology
- **(c)** Design Calculations

WORKING DRAWINGS

- **(a)** General
- **(b)** Top of Wall
- **(c)** Leveling Pad
- **(d)** Special Wall Interface Details
- **(e)** Earth Surcharges
- **(f)** Precast Concrete Panel Facing Layout

MSEW MATERIALS

- **(a)** General
- **(b)** MSEW With Precast Concrete Panel Facings
    - (1) Precast Concrete Panel Facing
        - **a.** Concrete
        - **b.** Reinforcing Steel
        - **c.** Casting
        - **d.** Markings
        - **e.** Finish
        - **f.** Tolerances
            1. Panel Dimensions
            2. Panel Squareness
            3. Panel Surface Finish
        - **g.** Compressive Strength
        - **h.** Rejection
        - **i.** Handling, Storage and Shipping
    - (2) Joint Material
        - **a.** Vertical Joints
        - **b.** Horizontal Joints
    - (3) Panel Coping

STATE PROJECT NO. 000-00-0000
SPECIAL PROVISIONS
(Pre-Qualified System Based Contracting)

(c) MSEW With Modular Concrete Block Facings
  (1) Modular Concrete Block Facing
    a. Concrete
    b. Casting
    c. Markings
    d. Finish
    e. Tolerances
    f. Compressive Strength
    g. Rejection
    h. Handling, Storage and Shipping
  (2) Block Fill
  (3) Cap Blocks
  (4) Block Coping
(d) Temporary MSEW Facing
  (1) Welded Wire Mesh Facing
  (2) Temporary Facing Aggregate
(e) Inextensible Soil Reinforcement
  (1) Reinforcing Steel Strips
  (2) Reinforcing Welded Wire Mesh
  (3) Galvanization Damage
(f) Extensible Soil Reinforcement
  (1) Geosynthetic Soil Reinforcement
  (2) Delivery, Storage, and Handling of Geosynthetic Materials
  (3) Quality Assurance Testing
(g) MSEW Certification Package
(h) Reinforced Backfill Material
  (1) Granular Backfill
  (2) Stone Backfill
  (3) Block Fill
  (4) Soil Property Requirements For All Backfill
  (5) Testing Frequency
(i) Reinforcement Attachment Devices
  (1) Tie Strips
  (2) Fasteners
  (3) Connector Pins
(j) Leveling Pad
(k) Geotextile Fabric
(l) Free Draining Aggregate
(m) Geomembrane

STATE PROJECT NO. 000-00-0000
SPECIAL PROVISIONS
(Pre-Qualified System Based Contracting)

CONSTRUCTION

(a) Wall Excavation and Foundation Preparation
(b) Leveling Pad Construction
(c) MSEW System Supplier's Representative
(d) Internal Drainage System
(e) Geotextile Fabric
(f) Wall Erection
(g) Reinforced Backfill Placement
(h) Soil Reinforcement Placement
(i) Final Construction Tolerances
(o) Surcharge
(k) Abutment Piling

MEASUREMENT AND PAYMENT

STATE PROJECT NO. 000-00-0000
SPECIAL PROVISIONS
(Pre-Qualified System Based Contracting)

ITEM S-000(A), MECHANICALLY STABILIZED EARTH WALL (MSEW): This item consists of designing, furnishing, and constructing a permanent Mechanically Stabilized Earth Wall (MSEW) with precast concrete panel or modular concrete block facings in accordance with these specifications and MSEW system supplier's recommendations, and in conformance with the lines, grades, design, and dimensions shown on the plans or established by the engineer. Design details for these MSEW structures such as specified geogrid, strip, or mesh; precast concrete panel or modular concrete block facing dimensions; loading conditions; leveling pad dimensions; temporary surcharge retaining walls; and details for appurtenances shall be as shown on the plans or as specified herein. No other MSEW systems will be considered other than those specified in the plans.

MSEW SUBMITTALS

The contractor shall submit design calculations and working drawings (shop drawings) to the Bridge Design Engineer in accordance with the policies and procedures that are detailed in subsection 801.03 and the requirements provided herein. The contractor shall allow 45 calendar days from the day the design calculations and the working drawings are received by the engineer for review and approval. Fabrication or any construction shall not begin prior to written approval of the design and working drawings. All plans and calculations shall bear the legible seal, date, and signature of the responsible Professional Civil Engineer registered in the State of Louisiana with the following Statement: ***"Certified with respect to structural adequacy and stability in accordance with LA DOTD requirements and procedures ".***

When MSEW Certification Packages are used to document the ultimate and allowable tensile load of extensible (geosynthetic) soil reinforcement, precast modular concrete block facing/soil reinforcement connection load (T_{ac}), and soil reinforcement pullout coefficients (F^*, α), the contractor shall submit the Certification package to the Pavement and Geotechnical Design Engineer for approval. The contractor shall allow 20 calendar days for review and approval of the Certification package. The geosynthetic soil reinforcement and modular concrete block facing shall not be delivered to the site without prior written approval of the MSEW system supplier's Certification package.

MSEW DESIGN

(a) Design Scope: The MSEW structures shall be considered gravity walls and shall be designed for external and internal stability of the reinforced soil mass. The Department will be responsible for the external stability, which shall consist of checking global stability for deep-seated failures, sliding stability, overturning, settlement analysis, and bearing of the reinforced soil mass. The external stability of the MSEW structure, with appropriate safety factors, is satisfied with the minimum base width required, B_{Req}, that is specified in the plans.

The contractor's MSEW system supplier shall be responsible for the internal stability design of the permanent MSEW structure. The supplier's design shall consist of determining the required soil reinforcement length and strength, facing/soil reinforcement connection strength,

and facing stability in accordance with the plans and this special provision. The supplier's design shall also specify the minimum required wall face batter to limit the amount of horizontal movements resulting from the outward rotation of the wall as a result of the development of internal equilibrium between the loads applied to the wall and the internal structure of the wall.

The supplier shall be responsible for the design of any temporary MSEW facings required during phase construction, temporary surcharge retaining walls located above the permanent MSEW structure, or other temporary construction systems that are required to build the permanent MSEW structure.

(b) General Design Methodology: The design of permanent MSEW and temporary construction systems shall be in accordance with the Department's *Geotechnical Engineering Design Guide No. 8, Mechanically Stabilized Earth Wall (MSEW) Design Guide,* and the 1997 interim or more current edition of the AASHTO "Standard Specifications for Highway Bridges." The Department will not accept designs based on methodology other than required by these specifications.

(c) Design Calculations: The contractor shall supply the Department with a complete set of the MSEW system supplier's design calculations in accordance with this specification. Computer generated designs used by the supplier shall be reviewed and approved by the Department. Verification that the computer program's design methodology meets the requirements provided herein, and the accuracy of the computer generated solution, shall be made by having the supplier submit a copy of the computer program with a complete, legible, hand calculation check for the most critical geometry and loading condition that will govern the design of the MSEW structure. The determination of all loading conditions shall be fully documented with all design calculations and assumptions. Submitted calculations (including computer runs) shall include all load cases that exist at completion and during construction for any required surcharges, hydraulic conditions, live loads, and loading combinations. A summary of the design computations, indicating design section, geometry, loadings, and analysis results shall be furnished with the design calculations.

WORKING DRAWINGS

(a) General: The drawings shall include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines, shown in the contract plans. The vertical bearing pressure exerted by the MSEW structure, relative to changes in wall height and soil reinforcement length shall be shown clearly on the plans. The working drawings shall also reflect all information needed to fabricate and erect the walls including:

1. Existing ground elevations that have been verified by the contractor for each location.
2. MSEW profile elevation showing top of the leveling pad elevations, maximum bearing loads, top of wall elevation, etc.;
3. Details of slip joints if required to prevent stresses due to anticipated settlement shown on the plans;

4. Details of all joints indicating type, size, and manufacturer;
5. Details of wall batter;
6. Shape and dimensions of MSEW facings;
7. The number, size, type, and details of the soil reinforcing elements;
8. Details of facing/reinforcement connections;
9. Details showing location and installation of geotextile fabric;
10. Details of the leveling pad showing dimensions;
11. Finishing details at the top of wall (i.e. cap block, panel coping)
12. Details at miscellaneous obstructions (i.e. utility conduits) located below the ground surface;
13. Details at bridge foundation obstructions;
14. Dimensions of structural backfill required;
15. Any additional details pertaining to coping, railing, temporary facing, and internal drainage, as required by the contract plans.

(b) Top of Wall: Written approval will be required to lower the top of wall elevations shown on the plans. The top of wall elevation for MSEW with modular concrete block facing may be increased to a maximum of 205 mm (8 inches) without written approval. The top of wall elevations shall be such as to allow for proper interfacing with barriers copings, surface ditches, bridge abutments, etc. as shown in the plans.

(c) Leveling Pad: Written approval will be required to raise the leveling pad elevations shown on the plans. Leveling pad embedment depths may be increased to a maximum of 500 mm (20 inches) without written approval. The leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown on the plans.

(d) Special Wall Interface Details: Should conditions arise within this project where a wall interfaces with another wall that will be constructed before, on, or after this contract, the working drawings shall contain special facing element details, wing wall slip joint details, and details on how to end this wall or walls and how to compact the embankment at these locations. The wall ends shall not be placed over pile supported footings.

For MSEW with precast concrete panel facings, the columns of panels that are adjacent to the interface location on this project will be modified in order to phase out the joint line produced under normal conditions to a joint that is vertical at the interface. The panels shall be modified as follows.

1. The modified panels shall be 50 mm (2 inches) thicker than the normal panel.
2. The side of the panel that coincides with the interface line shall be keyed in order to mate with the adjacent panel on the adjacent project.
3. The horizontal joint lines for the adjacent panels on either side of the interface shall be offset vertically by ½ panel.

(e) Earth Surcharges: Should the plans indicate an earth surcharge is to be placed over the reinforced zone, the surcharge may be retained by using a temporary MSEW structure.

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(f) Precast Concrete Panel Facing Layout: MSEW with precast concrete panel facing shall require a numbered panel layout drawing for fabrication and erection purposes.

MSEW MATERIALS

(a) General: The contractor shall make arrangements to purchase or manufacture all applicable materials such as the facing elements, soil reinforcements, geotextile fabric, facing aggregate, reinforced backfill materials, internal drainage system (if required), and all other necessary components. Written approval from the engineer shall be required to use materials or sources of materials not conforming to the specifications nor listed in the contract documents.

(b) MSEW With Precast Concrete Panel Facings:

(1) Precast Concrete Panel Facing: The precast concrete panels shall be fabricated in accordance with Section 8.13 of AASHTO, Division II, with the following exceptions and additions.

a. Concrete: Concrete shall meet the requirements of Section 901, except that a certified plant will not be required. The concrete shall conform to the requirements of Portland Cement Concrete Class AA with a minimum 28 day compressive strength of 27.6 MPa (4000 psi). Admixtures shall conform to Subsection 1011.02.

b. Reinforcing Steel: Unless noted otherwise in the plans, reinforcing steel shall be Grade 60 and shall meet the requirements of Section 1009. Fabrication and placement of reinforcing steel shall conform to Section 806.

c. Casting: The Fabrication Inspection unit of the Construction Division shall be notified 7 days prior to the production of precast concrete panels. The panels shall be cast on a flat surface, with the front face of the panel facing downward and the back face of the panel facing upward. Tie strip guide or other galvanized devices shall not be in contact with or be attached to the face panel reinforcement steel.

The concrete in each panel shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the form. The panels shall be cured with burlap for 36 hours or steam cured. Forms shall remain in place until they can be removed without damage to the panel. The panels may be shipped after reaching a minimum compressive strength of 27.6 MPa (4,000 psi).

d. Markings: The date of manufacture, the production lot number, and the panel identification number shall be clearly scribed on the rear face of each panel.

e. Finish: Concrete surfacing for the front face shall have a Class 2A, Special Surface Finish conforming to Subsection 805.13 and the rear face a uniform surface finish. The rear face of the panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of 6 mm (1/4 inch).

f. Tolerances: Precast concrete panels shall be manufactured within the following tolerances:

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1. Panel Dimensions: Position panel connection devices shall be within 25 mm (1 inch) of the specified dimension. All other dimensions shall be within 3 mm (1/8 inch) of the specified dimension.

2. Panel Squareness: Squareness as determined by the difference between the two diagonals shall not exceed 13 mm (1/2 inch).

3. Panel Surface Finish: Surface defects on smooth formed surfaces measured over a length of 1.5 m (5 feet) shall not exceed 8 mm (5/16 inch). Surface defects on the textured-finish surfaces measured over a length of 1.5 m (5 feet) shall not exceed 16 mm (5/8 inch).

g. Compressive Strength: Acceptance of the precast concrete panels with respect to compressive strength will be determined on a lot basis consisting of 38 cubic meters (50 cubic yards). The lot will be randomly sampled for compressive strength testing in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230. Test cylinders will be tested in sets of three at the times requested by the contractor until an average compressive strength of 27.6 MPa (4000 psi) is achieved, up to a maximum of 28 days with no individual test cylinder having a compressive strength less than 24.1 MPa (3500 psi). Panels represented by test cylinders that do not reach the above requirements will be rejected.

h. Rejection: Panels shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

1. Defects that indicate imperfect molding.
2. Defects indicating honeycomb or open texture concrete.
3. Cracked or severely chipped panels.
4. Color variation on front face of panel due to excess form oil or other reasons.

i. Handling, Storage and Shipping: Panels shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm blocking located immediately adjacent to tie strips to avoid bending the tie strips.

(2) Joint Material: Joint material shall be installed to the dimensions and thickness shown in the plans, or the approved working drawings.

a. Vertical Joints: Filler for vertical joints between panels shall be flexible foam strips.

b. Horizontal Joints: Filler for horizontal joints between panels shall conform to Subsection 1005.01 (a).

(3) Panel Coping: Panel coping shall be required unless shown otherwise in the plans. The panel coping shall be a cast-in-place or precast concrete cap that is placed over the upper most level of the precast concrete panels as detailed in the plans. The concrete shall be Class A concrete conforming to Section 901. Level up concrete may be necessary at the top row of MSEW precast concrete panel facings prior to placing panel coping. The stepped joint

line between the level up concrete and the top row of blocks shall not be exposed. A lip shall be constructed to produce a joint line parallel to the finished grade. Any necessary level up concrete shall be included in the cost of the wall. The level up concrete shall be Class M concrete conforming to Section 901.

(c) MSEW With Modular Concrete Block Facings

(1) Modular Concrete Block Facing: The modular concrete block supplier shall supply a Certificate of Delivery, on a Department approved form, listing particular lots shipped. It shall contain statements concerning the material's compliance with these specifications. A Certificate of Delivery shall be furnished with each shipment of modular concrete blocks delivered to the work site.

a. Concrete: The concrete mix design shall be submitted to the engineer for approval. The concrete shall be Portland Cement Concrete with a minimum 28 day compressive strength of 27.6 MPa (4000 psi). Maximum water absorption limit shall be 6%. Admixtures shall conform to Subsection 1011.02.

b. Casting: The Fabrication Inspection unit of the Construction Division shall be notified 7 days prior to the production of modular concrete blocks. The modular concrete blocks shall be cast in steel molds and in a manner that will assure the production of uniform modular concrete blocks. The concrete in each block shall be placed without interruption and shall be consolidated by the use of an approved method. The blocks shall be steam cured for a minimum of 24 hours. The blocks may be shipped after reaching a minimum compressive strength of 27.6 MPa (4,000 psi).

c. Markings: The date of manufacture, lot number, and type of block in accordance with the approved MSEW system drawings shall be clearly marked on each lot.

d. Finish: Concrete surfacing for the front face shall be as shown on the plans. The color of the modular concrete blocks shall be tan (sandstone) unless shown otherwise on the plans.

e. Tolerances: Modular concrete blocks shall be manufactured within the following tolerances:

1. The length and width of each individual block shall be within 3 mm (1/8 inch) of the specified dimension.
2. The height of each individual block shall be within 2 mm (1/16 inch) of the specified dimension.
3. Required Broken Face: When a broken or fractured face is required, the dimension of the front face shall be ±40 mm (± 1.5 inches) of the theoretical dimension shown on the plans.

f. Compressive Strength: Acceptance of the modular concrete blocks with respect to compressive strength will be determined on a per lot basis. The maximum number of blocks in each lot shall be 10,000. The lots shall be clearly marked until

acceptance of testing results. The lot will be randomly sampled in accordance with ASTM C 140. The manufacturer shall perform compressive strength tests, or test specimens shall be prepared by the manufacturer and submitted to the Department for testing. Compressive strength test specimens shall conform to the saw-cut coupon provisions of section 5.2.4 of ASTM C 140. Block lots shall be approved when the average compressive strength is 27.6 MPa (4000 psi) of 3 test coupons and with no individual test having a compressive strength less than 24.1 MPa (3500 psi). Block lots not reaching the above requirements shall be rejected.

g. Rejection: Modular concrete blocks shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

1. Defects that indicate imperfect molding.
2. Defects indicating honeycomb or open texture concrete.
3. Cracked or severely chipped blocks.
4. Color variation on front face of block due to excess form oil or other reasons.

h. Handling, Storage and Shipping: Modular concrete blocks shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, or fractures.

(2) Block Fill: When modular concrete blocks require a block fill, the block fill material requirements referenced under the reinforced backfill specification of this special provision shall be used.

(3) Cap Blocks: Cap blocks shall be required unless shown otherwise in the plans. The cap blocks shall be a precast concrete cap that is placed over the uppermost level of blocks. Cap blocks shall be secured with an epoxy adhesive from an approved source listed in QPL 32. Epoxy adhesive shall provide a minimum of 50 percent surface coverage and shall not be allowed to drip down the front face of the wall.

(4) Block Coping: If required in the plans, a cast-in-place concrete coping shall be placed over the upper most level of modular concrete blocks as indicated in the plans or as shown on the approved working drawings. The concrete shall be Class A conforming to Section 901.

(d) Temporary MSEW Facing:

(1) Welded Wire Mesh Facing: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-55). Galvanization, if required, shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111).

(2) Temporary Facing Aggregate: The temporary facing aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

(e) Inextensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability.

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Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Reinforcing Steel Strips: Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM A 572 Grade 65 (AASHTO M-223) or equal. Galvanization shall conform to the minimum requirements or ASTM A-123 (AASHTO M- 111).

(2) Reinforcing Welded Wire Mesh: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-55). Galvanization shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M- 111).

(3) Galvanization Damage: Any damage done to the galvanization prior to the soil reinforcement installation shall be repaired with a cold galvanizing repair compound conforming to Subsection 1008.06 to provide a galvanized coating comparable to that provided by ASTM A 123 (AASHTO M- 111).

(f) Extensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Geosynthetic Soil Reinforcement: Geosynthetic design requirements shall be as shown in the plans and specified in the working drawings. Geotextile reinforcement shall be a woven geotextile consisting only of long chain polymeric filaments or yarns formed into a stable network. Geogrid reinforcements shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. The structure of geosynthetic reinforcements shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.

(2) Delivery, Storage, and Handling of Geosynthetic Materials: The contractor shall check the geosynthetic soil reinforcement upon delivery to ensure that the proper material has been received. Geosynthetic rolls shall be labeled per ASTM D 4837, Guide for Identification, Storage, and Handling of Geosynthetic Rolls. During all periods of shipment and storage, the geosynthetic materials shall be protected from temperatures greater than 60°C (140 degrees Fahrenheit), mud, dirt, dust, and debris. The manufacturer's recommendations regarding protection from direct sunlight should be followed. At the time of installation, the geosynthetic materials shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The contractor, at no additional cost to the Department, shall replace any geotextile fabric or geosynthetic reinforcement damaged during storage or installation.

(3) Quality Assurance Testing: All geosynthetic soil reinforcements, regardless of prior approval, shall be sampled in accordance with the Materials Sampling Manual and tested by the Department for quality assurance. The ultimate tensile strength must meet the

strength required to achieve the specified T_a or T_{ac} , based on the reduction factors and the required factor of safety from an approved manufacturer's Certification Package. If the type of geosynthetic soil reinforcement selected by the contractor requires special clamps or testing procedures other than those normally used by the Department, the engineer may require the contractor to supply the quality assurance testing as required by the Department to determine the ultimate tensile strength at no additional cost to DOTD. The Department shall supply the test samples collected to a DOTD approved independent laboratory for quality assurance testing. No geosynthetic soil reinforcement shall be used to construct the MSEW structure until the results of the quality assurance testing indicate that the soil reinforcement delivered to the site is in conformance with these specifications and the approved manufacturer's Certification Package.

(g) MSEW Certification Package: The contractor shall submit a Certification Package prepared by the MSEW supplier or MSEW component manufacturer. The MSEW Certification Package shall include a Certificate of Compliance that certifies the following (as applicable to the MSEW system):

1. The ultimate tensile strength, T_{ULT}, (MARV) for extensible soil reinforcements (geosynthetics).
2. The allowable tensile load, T_a, multiplied by the reinforcement coverage ratio, Rc, meets or exceeds the MSE block wall's maximum applied tensile load, T_{max}.
3. The allowable connection load between the modular concrete block facing and the soil reinforcement, T_{ac}, multiplied by the reinforcement coverage ratio, R_c, meets or exceeds the MSE block wall's maximum applied load to the soil reinforcement connection, T_o at the wall facing.
4. The geosynthetic's pullout coefficients (**F***, α) meet or exceed the MSEW's required design pullout coefficients.

The certified values shall be documented as indicated in the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide.* In case of a dispute over the validity of values, testing shall be performed by DOTD. For tests unable to be performed by DOTD, the engineer will require the contractor to supply test data from a DOTD approved independent laboratory to support the certified values. These additional tests shall be performed at no additional cost to the Department. If in the opinion of the engineer, the required documentation is not provided for individual reduction factors (RF) or pullout coefficients (F*, α), default values for these design parameters shall be used in accordance with the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide. If* the MSEW supplier chooses to use default values, the Certificate of Compliance shall indicate this.

(h) Reinforced Backfill Material: The reinforced backfill material shall be a select granular material unless a stone backfill is specified in the plans. The granular and stone backfills shall conform to Subsection 1003.01 with the following engineering properties and material requirements.

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(1) Granular Backfill: The internal friction angle (φ) for the reinforced granular backfill shall not be less than 30 degrees. The granular backfill material shall have the gradation shown in Table 2.

Table 2 - Reinforced Granular Backfill Gradation

Sieve Size	Percent Passing
19 mm (¾")	100
4750 µm (No. 4)	20 - 100
2000 µm (No. 10)	15 - 85
425 µm (No. 40)	10 - 35
150 µm (No. 100)	0 - 10
75 µm (No. 200)	0 - 5

(2) Stone Backfill: The internal friction angle (φ) for the reinforced stone backfill shall not be less than 34 degrees. The stone backfill material shall have the gradation shown in Table 3.

Table 3 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
9.5 mm (⅜)	20 - 55
4750 µm (No. 4)	0 - 10
2360 µm (No. 8)	0 - 5

(3) Block Fill: The block fill shall be crushed stone or crushed gravel with the gradation shown in Table 3. The block fill shall have a minimum of 75 percent crushed material retained on a 4750 µm (No. 4).

Table 4 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
2360 µm (No. 8)	0 - 10
300 µm (No. 50)	0 - 5

(4) Soil Property Requirements For All Backfill: All reinforced backfill and modular concrete block fill shall have the following soil properties:

1. pH values shall range between 4.5 and 9.0 (TR 430).

2. Organic content shall not exceed 0.5 percent (weight of organic material to weight of total sample as determined by TR 413).
3. Internal friction angle shall not be less than the values specified above as determined by the standard direct shear test, AASHTO T-236 or the triaxial test, AASHTO T-234. Material test samples shall be compacted to 95% of maximum density at optimum moisture content as determined by DOTD TR 418.

The reinforced backfill and modular concrete block fill shall have the following electrochemical properties if steel soil reinforcements are used:

1. The resistivity shall be greater than 3000 ohm-cm DOTD TR-429.
2. The chloride content shall be less than 100 ppm AASHTO T-291.
3. The sulfate content shall be less than 200 ppm AASHTO T-290.

(5) **Testing Frequency:** All soil property requirements shall be tested during initial source approval or if a change in source is requested. Reinforced backfill material shall be sampled once every 770 cubic meters (1,000 cubic yards) and tested for gradation and pH. Reinforced backfill material shall be sampled once every 3800 cubic meters (5,000 cubic yards) and tested for internal friction angle, organic content, resistivity, chloride content, and sulfate content. A variation in testing frequency may be required if a variation in material gradation or composition is observed.

(i) **Reinforcement Attachment Devices:** All reinforcing and attachment devices shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing and attachment devices will be sampled and tested by the Department before fabrication or erection of the MSEW.

(1) **Tie Strips:** The tie strips shall be shop-fabricated of a hot rolled steel conforming to the minimum requirements of ASTM 570, Grade 50 or equal. Galvanization shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111).

(2) **Fasteners:** Fasteners shall consist of hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of ASTM A-325 (AASHTO M-164) or equal and galvanized in accordance with ASTM A-153.

(3) **Connector Pins:** Connector pins and mat bars shall be fabricated from A-36 steel and welded to the soil reinforcement mats as shown on the plans. Galvanization shall conform to ASTM A-123 (AASHTO M-111). Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of ASTM A-82 (AASHTO M-32) and galvanized in accordance with ASTM A-123 (AASHTO M-111).

(j) **Leveling Pad:** An unreinforced concrete leveling pad shall be constructed as shown in the plans. The leveling pad shall be class M concrete conforming to Section 901.

(k) Geotextile Fabric: The fabric shall be in accordance with Section 1019, classes B, C, or D. The fabric shall be resistant to chemical, biological, and insect attack.

(l) Free Draining Aggregate: The free draining aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

(m) Geomembrane: If required in the plans, a single-layer continuous polymeric sheet shall be placed as indicated in the plans. The geomembrane shall be manufactured from a virgin polymeric resign. The geomembrane shall conform to the following requirements:

Property	Test Method	Minimum Requirements
Thickness, mm (mills)	ASTM D 5199	1.00 (40)
Tensile, kN/m (lb/in.)	ASTM D 882 25 mm (1 in.) strip	12.2 (70)
Tear, N (lb.)	ASTM D 1004 Die C	90 (20)
Puncture, N (lb.)	ASTM D 4833 modified	180 (40)
Impact, J (ft.-lb.)	ASTM D 1424 modified	19 (25)

CONSTRUCTION

(a) Wall Excavation and Foundation Preparation: Wall excavation and foundation preparation shall be in accordance with the special provisions for MSEW Structural Excavation and Backfill.

(b) Leveling Pad Construction: At each MSEW foundation level, a precast reinforced or cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The leveling pad shall be cured a minimum of 12 hours before placement of wall blocks. If the permanent MSEW facing shall be installed in front of a temporary MSEW facing, the leveling pad shall be installed-just prior to construction of the permanent MSEW facing.

(c) MSEW System Supplier's Representative: The MSEW system supplier shall provide qualified and experienced advisory personnel at the start of the wall construction and until such time that the engineer feels the DOTD inspectors and the contractor's personnel are adequately acquainted with the MSEW construction procedures and no longer require technical assistance. The representative shall also be available on an as needed basis, as requested by the engineer, during construction of the MSEW structures.

(d) Internal Drainage System: If required in the plans, an internal drainage system shall be installed behind the wall as indicated in the plans or as shown on the approved working drawings. Outlet pipes shall be placed at sags in the flow line, at the low end of the collector

pipe, and at other locations shown or specified. Location and elevation of the internal drainage system shall be determined by the contractor and submitted to the engineer for approval.

(e) Geotextile Fabric: MSEW with precast concrete panel facings shall have a geotextile fabric covering all joints between panels on the back side of the wall. The geotextile fabric shall have a minimum width of 300 mm (12 inches) and shall overlap adjacent geotextile fabrics a minimum of 100 mm (4 inches). Geotextile fabric shall be adhered to panels by applying adhesive to the back of the panel on each side of the joint. Adhesive shall not be applied directly on the geotextile fabric or within 50 mm (2 inches) of the panel joint edge.

MSEW with modular concrete block facings and granular reinforced backfill shall have geotextile fabric placed between the block fill and the reinforced backfill. Geotextile fabric will not be required if a stone reinforced backfill is used.

If required in the plans, geotextile fabric shall be placed between the natural ground and the reinforced backfill. The subgrade to receive the geotextile fabric shall be free of loose or extraneous material and sharp objects that may damage the geotextile fabric during installation. The geotextile fabric shall be stretched, aligned, and placed in a wrinkle-free manner with intimate contact with the soil. Adjacent geotextile fabric edges shall be overlapped a minimum of 0.5 m (1.5 feet).

If approved by the engineer, torn or punctured sections of the geotextile fabric may be repaired or replaced. Geotextile fabric damaged during installation by tearing or puncturing shall be cut out and replaced completely or repaired by placing a piece of fabric that is large enough to cover the damaged area and provide a sufficient overlap minimum 0.5 m (1.5 feet) on all sides to secure the damaged geotextile fabric area.

(f) Wall Erection: Precast concrete panels and modular concrete block facings shall be placed so that their final position is vertical or battered as shown on the plans. Precast concrete panels and modular concrete block facings shall be placed in successive horizontal lifts in the sequence directed by the engineer as backfill placement proceeds. The MSEW structure shall be constructed using a predetermined backward batter corresponding to the anticipated outward wall deflection due to the active soil pressures. This backward batter shall be determined by the MSEW system supplier and may be adjusted in the field as directed by the engineer during construction.

MSEW with precast concrete panels shall be handled by a lifting device set into the upper edge of the panels or other approved method. The first level of precast concrete panels shall be placed directly on the concrete leveling pad. Horizontal joint material or wooden shims shall not be permitted between the first course of panels and the leveling pad. As backfill material is placed behind a panel, the panel shall be maintained in position by means of temporary wooden wedges or bracing in accordance with the MSEW system supplier's recommendations. The wooden wedges shall be removed as soon as the panel above the wedged panel is completely erected and backfilled. External bracing shall be required for the first lift of precast concrete panels.

(g) Reinforced Backfill Placement: Backfill placement shall closely follow the erection of each lift of facing elements. At each level of soil reinforcement, the backfill material shall be

roughly leveled to an elevation approximately 25 mm (1 inch) above the level of the connection at the facing before placing the soil reinforcement. Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials. Any wall materials, which become damaged during backfill placement, shall be removed and replaced at the contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

The optimum moisture content and maximum dry weight density shall be determined by DOTD TR 418. Backfill shall be compacted in accordance with Section 203 to 95 percent of the maximum dry density in accordance with DOTD TR 401. Compaction control testing of the reinforced backfill shall be performed with a minimum frequency of one test per every 1.5 m (5 feet) of wall height for every 30 m (100 feet) of wall. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The maximum lift thickness (loose) will be 200 mm (8 inches) and shall closely follow the MSEW facing erection. The contractor shall decrease this lift thickness if necessary to obtain the specified density. Backfill compaction shall be accomplished without disturbance to or distortion of the reinforcement. A minimum of 150 mm (6 inches) of backfill material shall be maintained at all times between the contractor's equipment and the soil reinforcement or geotextile fabric. Compaction adjacent to the backside of the wall facing, within a 1 m (3 foot) wide area, shall be achieved by using light mechanical tampers. Sheepsfoot or grid-type rollers shall not be used for compacting backfill within the soil reinforced backfill.

At the end of each day's operations, the contractor shall shape the last level of backfill to permit runoff of rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall reinforcement zone until this zone is protected from infiltration. Any damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill or retained backfill shall be repaired at the contractor's expense.

(h) Soil Reinforcement Placement: The soil reinforcement shall be installed in accordance with the manufacturer's recommendations and these specifications. The soil reinforcement shall be placed within the layers of the compacted backfill material at the locations shown on the plans. The contractor shall only place that amount of soil reinforcement required for immediately pending work to prevent undue damage. Soil reinforcement shall be placed with the strongest direction of soil reinforcement perpendicular to the wall face, unless shown otherwise in the plans. The soil reinforcement shall be connected to the MSEW facing in accordance with the MSEW system supplier's recommendations. The soil reinforcement shall then be laid flat and uniformly tensioned to remove any slack in the connection or soil reinforcement material.

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(i) Final Construction Tolerances: The vertical tolerances (plumbness) and horizontal alignment tolerance shall not exceed 20 mm (3/4 inch) when measured along a 3 m (10 feet) straight edge. The vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 6 mm per meter (1/4 inch per 3 feet) of wall height. The tolerances shall be net measurements after allowance is given for the offset batter of the MSEW facing.

(j) Surcharge: Should the contract indicate an earth surcharge to be placed over the reinforced zone, the surcharge shall be retained by utilizing a temporary wall. The temporary wall may be built with a temporary MSEW or other approved method. The face of the temporary wall shall be placed within 300 mm (1 foot) of the permanent wall face. The top surface of the surcharge shall allow the surface water to drain away from the wall. A plastic membrane shall be placed over the reinforced zone prior to placing the surcharge material. Materials and the placement and removal of the temporary wall shall be included in the cost of the wall unless indicated otherwise on the plans.

(k) Abutment Piling: If abutments supported on piling are to be placed in the reinforced zone, the following requirements and sequence shall be adhered to unless otherwise indicated in the plans.

1. Drive all piles within the reinforced zone prior to installation.
2. Encase each pile in a Smooth Wall or Corrugated Galvanized Steel (SWCGS) pipe of sufficient thickness to prevent buckling or distortion during placement and compaction of wall backfill. Payment to be included in the cost of the wall.
3. Place spacers between the pile and the SWCGS pipe to prevent the pipe from coming in contact with the pile during backfilling of the wall.
4. Extend the SWCGS pipe from the bottom of the backfill to the bottom of the bridge abutment cap.
5. After positioning, seal the top of the SWCGS pipe to prevent debris accumulation during placement of wall backfill, and keep the pipe sealed until filled with granular material.
6. Fill the SWCGS pipe loosely with granular material after completion of wall construction as directed and approved by the engineer.

MEASUREMENT AND PAYMENT

Mechanically Stabilized Earth Walls, complete in place and accepted, will be paid for at the contract unit price bid per square meter (square foot) which includes furnishing all materials, labor, equipment, and other incidentals required to complete this item of work. Payment will include, but shall not be limited to the following items: precast concrete panels or modular concrete blocks, galvanized steel reinforcing and tie strips or galvanized steel mesh and mesh connectors or geosynthetic reinforcement, geotextile fabric, level up concrete, coping, leveling pad, perforated pipe, drain pipe, temporary surcharge wall, and special backfill material requirements.

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Excavation below the original ground line and subsequent backfill to the original ground line required for the construction of the MSEW structure will be paid for in accordance with the special provisions for MSEW Structural Excavation and Backfill.

Embankment or reinforced backfill material placed above the original ground line will be measured and paid for under Section 203. Additional costs associated with its special material requirements will be included in the Mechanically Stabilized Earth Wall item.

When changes in the work are ordered by the engineer, which vary the square meter (square foot) wall quantity shown on the plans, the additional MSEW quantity shall be paid for at the contract unit price.

Payment will be made under:

Item S-000(A), Mechanically Stabilized Earth Wall *(MSEW system supplier)*, per square meter (square foot)

APPENDIX E

SPECIAL PROVISIONS

MECHANICALLY STABILIZED EARTH WALL (MSEW) (PRE-DESIGNED SYSTEM BASED)

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

GEDG NO. 8 (10/01/99)

SAMPLE SPECIFICATIONS

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ITEM S-000(A), MECHANICALLY STABILIZED EARTH WALL (MSEW)

MSEW MATERIALS

- **(a)** General
- **(b)** MSEW With Precast Concrete Panel Facings
  - (1) Precast Concrete Panel Facing
    - **a.** Concrete
    - **b.** Reinforcing Steel
    - **c.** Casting
    - **d.** Markings
    - **e.** Finish
    - **f.** Tolerances
      1. Panel Dimensions
      2. Panel Squareness
      3. Panel Surface Finish
    - **g.** Compressive Strength
    - **h.** Rejection
    - **i.** Handling, Storage and Shipping
  - (2) Joint Material
    - **a.** Vertical Joints
    - **b.** Horizontal Joints
  - (3) Panel Coping
- (c) MSEW With Modular Concrete Block Facings
  - (1) Modular Concrete Block Facing
    - **a.** Concrete
    - **b.** Casting
    - **c.** Markings
    - **d.** Finish
    - **e.** Tolerances
    - **f.** Compressive Strength
    - **g.** Rejection
    - **h.** Handling, Storage and Shipping
  - (2) Block Fill
  - (3) Cap Blocks
  - (4) Block Coping
- **(d)** Temporary MSEW Facing
  - (1) Welded Wire Mesh Facing
  - (2) Temporary Facing Aggregate

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(e) Inextensible Soil Reinforcement
  (1) Reinforcing Steel Strips
  (2) Reinforcing Welded Wire Mesh
  (3) Galvanization Damage
(f) Extensible Soil Reinforcement
  (1) Geosynthetic Soil Reinforcement
  (2) Delivery, Storage, and Handling of Geosynthetic Materials
  (3) Quality Assurance Testing
(g) Reinforced Backfill Material
  (1) Granular Backfill
  (2) Stone Backfill
  (3) Block Fill
  (4) Soil Property Requirements For All Backfill
  (5) Testing Frequency
(h) Reinforcement Attachment Devices
  (1) Tie Strips
  (2) Fasteners
  (3) Connector Pins
(i) Leveling Pad
(j) Geotextile Fabric
(k) Free Draining Aggregate
(l) Geomembrane

CONSTRUCTION

(a) Wall Excavation and Foundation Preparation
(b) Leveling Pad Construction
(c) MSEW System Supplier's Representative
(d) Internal Drainage System
(e) Geotextile Fabric
(f) Wall Erection
(g) Reinforced Backfill Placement
(h) Soil Reinforcement Placement
(i) Final Construction Tolerances
(j) Surcharge
(k) Abutment Piling

MEASUREMENT AND PAYMENT

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ITEM S-000(A), MECHANICALLY STABILIZED EARTH WALL (MSEW): This item consists of furnishing, and constructing a permanent Mechanically Stabilized Earth Wall (MSEW) with precast concrete panel or modular concrete block facings in accordance with these specifications and MSEW system supplier's recommendations, and in conformance with the lines, grades, design, and dimensions shown on the plans or established by the engineer. Design details for these MSEW structures such as specified geogrid, strip, or mesh; precast concrete panel or modular concrete block facing dimensions; loading conditions; leveling pad dimensions; temporary surcharge retaining walls; and details for appurtenances shall be as shown on the plans or as specified herein. No other MSEW systems will be considered other than those specified in the plans.

MSEW MATERIALS

(a) General: The contractor shall make arrangements to purchase or manufacture all applicable materials such as the facing elements, soil reinforcements, geotextile fabric, facing aggregate, reinforced backfill materials, internal drainage system (if required), and all other necessary components. Written approval from the engineer shall be required to use materials or sources of materials not conforming to the specifications nor listed in the contract documents.

(b) MSEW With Precast Concrete Panel Facings:

(1) Precast Concrete Panel Facing: The precast concrete panels shall be fabricated in accordance with Section 8.13 of AASHTO, Division 11, with the following exceptions and additions.

a. Concrete: Concrete shall meet the requirements of Section 901, except that a certified plant will not be required. The concrete shall conform to the requirements of Portland Cement Concrete Class AA with a minimum 28 day compressive strength of 27.6 MPa (4000 psi) or as shown in the plans. Admixtures shall conform to Subsection 1011.02.

b. Reinforcing Steel: Unless noted otherwise in the plans, reinforcing steel shall be Grade 60 and shall meet the requirements of Section 1009. Fabrication and placement of reinforcing steel shall conform to Section 806.

c. Casting: The panels shall be cast on a flat surface, with the front face of the panel facing downward and the back face of the panel facing upward. Tie strip guide or other galvanized devices shall not contact or be attached to the face panel reinforcement steel.

The concrete in each panel shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the form. The panels shall be cured with burlap for 36 hours or steam cured. Forms shall remain in place until they can be removed without damage to the panel. The panels may be shipped after reaching a minimum compressive strength of 27.6 MPa (4,000 psi).

d. Markings: The date of manufacture, the production lot number, and the panel identification number shall be clearly scribed on the rear face of each panel.

e. Finish: Concrete surfacing for the front face shall have a Class 2A, Special Surface Finish conforming to Subsection 805.13 and the rear face a uniform surface

finish. The rear face of the panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of 6 mm (1/4inch).

f. Tolerances: Precast concrete panels shall be manufactured within the following tolerances:

1. Panel Dimensions: Position panel connection devices shall be within 25 mm (1 inch) of the specified dimension. All other dimensions shall be within 3 mm (1/8 inch) of the specified dimension.

2. Panel Squareness: Squareness as determined by the difference between the two diagonals shall not exceed 13 mm (1/2 inch).

3. Panel Surface Finish: Surface defects on smooth formed surfaces measured over a length of 1.5 m (5 feet) shall not exceed 8 mm (5/16 inch). Surface defects on the textured-finish surfaces measured over a length of 1.5 m (5 feet) shall not exceed 16 mm (5/8 inch).

g. Compressive Strength: Acceptance of the precast concrete panels with respect to compressive strength will be determined on a lot basis consisting of 38 cubic meters (50 cubic yards). The lot will be randomly sampled with a single compressive strength sample consisting of 6 cylinders in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230. Test cylinders will be tested in sets of two at the times requested by the contractor until an average compressive strength of 27.6 MPa (4000 psi) is achieved, up to a maximum of 28 days. Panels represented by test cylinders that do not reach an average compressive strength of 27.6 MPa (4000 psi) will be rejected.

h. Rejection: Panels shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

1. Defects that indicate imperfect molding.
2. Defects indicating honeycomb or open texture concrete.
3. Cracked or severely chipped panels.
4. Color variation on front face of panel due to excess form oil or other reasons.

i. Handling, Storage and Shipping: Panels shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported on firm blocking located immediately adjacent to tie strips to avoid bending the tie strips.

(2) Joint Material: Joint material shall be installed to the dimensions and thickness shown in the plans, or approved shop drawings.

a. Vertical Joints: Filler for vertical joints between panels shall be flexible foam strips.

b. Horizontal Joints: Filler for horizontal joints between panels shall conform to Subsection 1005.01 (a).

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(3) Panel Coping: Panel coping shall be required unless shown otherwise in the plans. The panel coping shall be a cast-in-place or precast concrete that is placed over the upper most level of precast concrete panels as detailed in the plans. The concrete shall be Class A concrete conforming to Section 901. Level up concrete may be necessary at the top row of MSEW precast concrete panel facings prior to placing panel coping. The stepped joint line between the level up concrete and the top row of blocks shall not be exposed. A lip shall be constructed to produce a joint line parallel to the finished grade. Any necessary level up concrete shall be included in the cost of the wall. The level up concrete shall be Class M concrete conforming to Section 901.

(c) MSEW With Modular Concrete Block Facings

(1) Modular Concrete Block Facing: The modular concrete block supplier shall supply a Certificate of Delivery, on a Department approved form, listing particular lots shipped. It shall contain statements concerning the material's compliance with these specifications. A Certificate of Delivery shall be furnished with each shipment of modular concrete blocks delivered to the work site.

a. Concrete: Concrete shall meet the requirements of Section 901, except that a certified plant will not be required. The concrete shall be Portland Cement Concrete Class A with a minimum 28 day compressive strength of 27.6 MPa (4000 psi) or as shown in the plans. Maximum water absorption limit shall be 5% unless approved otherwise in writing by the engineer. Admixtures shall conform to Subsection 101 1.02.

b. Casting: The modular concrete blocks shall be cast in steel molds and in a manner that will assure the production of uniform modular concrete blocks. The concrete in each block shall be placed without interruption and shall be consolidated by the use of an approved method. The blocks shall be steam cured for a minimum of 24 hours. The blocks may be shipped after reaching a minimum compressive strength of 27.6 MPa (4,000 psi).

c. Markings: The date of manufacture, lot number, and type of block in accordance with the approved MSEW system drawings shall be clearly marked on each lot.

d. Finish: Concrete surfacing for the front face shall be as shown on the plans. The color of the modular concrete blocks shall be tan (sandstone) unless shown otherwise on the-plans.

e. Tolerances: Modular concrete blocks shall be manufactured within the following tolerances:

1. The length and width of each individual block shall be within 3 mm (1/8 inch) of the specified dimension.
2. The height of each individual block shall be within 2 mm (1/16 inch) of the specified dimension.

3. Required Broken Face: When a broken or fractured face is required, the dimension of the front face shall be ±40 mm (±1.5 inches) of the theoretical dimension shown on the plans.

f. Compressive Strength: Acceptance of the modular concrete blocks with respect to compressive strength will be determined on a per lot basis. The maximum number of blocks in each lot shall be 10,000. The lots shall be clearly marked until acceptance of testing results. The lot will be randomly sampled in accordance with ASTM C 140. The manufacturer shall perform compressive strength tests, or test specimens shall be prepared by the manufacturer and submitted to the Department for testing. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of section 5.2.4 of ASTM C 140. Blocks represented by test coupons that do not reach an average compressive strength of 27.6 MPa (4000 psi) will be rejected.

g. Rejection: Modular concrete blocks shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

1. Defects that indicate imperfect molding.
2. Defects indicating honeycomb or open texture concrete.
3. Cracked or severely chipped blocks.
4. Color variation on front face of block due to excess form oil or other reasons.

h. Handling, Storage and Shipping: Modular concrete blocks shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, or fractures.

(2) Block Fill: When modular concrete blocks require a block fill, the block fill material requirements referenced under the reinforced backfill specification of this special provision shall be used.

(3) Cap Blocks: Cap blocks shall be required unless shown otherwise in the plans. The cap blocks shall be a precast concrete cap that is placed over the uppermost level of blocks. Cap blocks shall be secured with an epoxy adhesive from an approved source listed in QPL 32. Epoxy adhesive shall provide a minimum of 50 percent surface coverage and shall not be allowed to drip down the front face of the wall.

(4) Block Coping: If required in the plans, a cast-in-place concrete coping shall be placed over the upper most level of modular concrete blocks as indicated in the plans or as shown on the approved working drawings. The concrete shall be Class A conforming to Section 901.

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(d) Temporary MSEW Facing:

(1) Welded Wire Mesh Facing: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements Of ASTM A-82 (AASHTO M-55). Galvanization, if required, shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M- 111).

(2) Temporary Facing Aggregate: The temporary facing aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

(e) Inextensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Reinforcing Steel Strips: Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM A 572 Grade 65 (AASHTO M-223) or equal. Galvanization shall conform to the minimum requirements or ASTM A-123 (AASHTO M-111).

(2) Reinforcing Welded Wire Mesh: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-55). Galvanization shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111).

(3) Galvanization Damage: Any damage done to the galvanization prior to the soil reinforcement installation shall be repaired with a cold galvanizing repair compound conforming to Subsection 1008.06 to provide a galvanized coating comparable to that provided by ASTM A 123 (AASHTO M-111).

(f) Extensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Geosynthetic Soil Reinforcement: Geosynthetic design requirements shall be as shown in the plans and specified in the working drawings. Geotextile reinforcement shall be a woven geotextile consisting only of long chain polymeric filaments or yams formed into a stable network. Geogrid reinforcements shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. The structure of geosynthetic reinforcements shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.

(2) Delivery, Storage, and Handling of Geosynthetic Materials: The contractor shall check the geosynthetic soil reinforcement upon delivery to ensure that the proper material has been received. During all periods of shipment and storage, the geosynthetic materials shall be protected from temperatures greater than 60°C (140 degrees Fahrenheit), mud,

dirt, dust, and debris. The manufacturer's recommendations regarding protection from direct sunlight should be followed. At the time of installation, the geosynthetic materials shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The contractor, at no additional cost to the Department, shall replace any geotextile fabric or geosynthetic reinforcement damaged during storage or installation.

(3) Quality Assurance Testing: All geosynthetic soil reinforcements, regardless of prior approval, shall be sampled in accordance with the Materials Sampling Manual and tested by the Department for quality assurance. The ultimate tensile strength must meet the strength required to achieve the specified T_a or T_{ac}, based on the reduction factors and the required factor of safety as specified in the plans. If the type of geosynthetic soil reinforcement selected by the contractor requires special clamps or testing procedures other than those normally used by the Department, the engineer may require the contractor to supply the quality assurance testing as required by the Department to determine the ultimate tensile strength at no additional cost to DOTD. The Department shall supply the test samples collected to a DOTD approved independent laboratory for quality assurance testing. No geosynthetic soil reinforcement shall be used to construct the MSEW structure until the results of the quality assurance testing indicate that the soil reinforcement delivered to the site is in conformance with these specifications.

(g) Reinforced Backfill Material: The reinforced backfill material shall be a select granular material unless a stone backfill is specified in the plans. The granular and stone backfills shall conform to Subsection 1003.01 with the following engineering properties and material requirements.

(1) Granular Backfill: The internal friction angle (φ) for the reinforced granular backfill shall not be less than 30 degrees. The granular backfill material shall have the gradation shown in Table 2.

Table 2 - Reinforced Granular Backfill Gradation

Sieve Size	Percent Passing
19 mm (¾")	100
4750 µm (No. 4)	20 - 100
2000 µm (No. 10)	15 - 85
425 µm (No. 40)	10 - 60
75 µm (No. 200)	0 - 15

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(2) Stone Backfill: The internal friction angle (φ) for the reinforced stone backfill shall not be less than 34 degrees. The stone backfill material shall have the gradation shown in Table 3.

Table 3 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 – 100
9.5 mm (⅜")	20 – 55
4750 µm (No. 4)	0 – 10
2360 µm (No. 8)	0 – 5

(3) Block Fill: The block fill shall be crushed stone or crushed gravel with the gradation shown in Table 3. The block fill shall have a minimum of 75 percent crushed material retained on a 4750 µm No. 4 sieve.

Table 4 – Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
2360 µm (No. 8)	0 - 10
300 µm (No. 50)	0 - 5

(4) Soil Property Requirements For All Backfill: All reinforced backfill and modular concrete block fill shall have the following soil properties:

1. pH values shall range between 4.5 and 9.0 (TR 430).
2. Organic content shall not exceed 0.5 percent (weight of organic material to weight of total sample as determined by TR 413).
3. Internal friction angle shall not be less than the values specified above as determined by the standard direct shear test, AASHTO T-236 or the triaxial test, AASHTO T-234. Material test samples shall be compacted to 95% of maximum density at optimum moisture content as determined by DOTD TR 418.

The reinforced backfill and modular concrete block fill shall have the following electrochemical properties if steel soil reinforcements are used:

1. The resistivity shall be greater than 3000 ohm-cm DOTD TR 429.
2. The chloride content shall be less than 100 ppm AASHTO T-291.

3. The sulfate content shall be less than 200 ppm AASHTO T-290.

(5) Testing Frequency: All soil property requirements shall be tested during initial source approval or if a change in source is requested. Reinforced backfill material shall be sampled once every 770 cubic meters (1,000 cubic yards) and tested for gradation and pH. Reinforced backfill material shall be sampled once every 3800 cubic meters (5,000 cubic yards) and tested for internal friction angle, organic content, resistivity, chloride content, and sulfate content. A variation in testing frequency may be required if a variation in material gradation or composition is observed.

(h) Reinforcement Attachment Devices: All reinforcing and attachment devices shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing and attachment devices will be sampled and tested by the Department before fabrication or erection of the MSEW.

(1) Tie Strips: The tie strips shall be shop-fabricated of a hot rolled steel conforming to the minimum requirements of ASTM 570, Grade 50 or equal. Galvanization shall conform to the minimum requirements of ASTM A-123 (AASHTO M- 111).

(2) Fasteners: Fasteners shall consist of hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of ASTM A-325 (AASHTO M-164) or equal and galvanized in accordance with ASTM Al53.

(3) Connector Pins: Connector pins and mat bars shall be fabricated from A-36 steel and welded to the soil reinforcement mats as shown on the plans. Galvanization shall conform to ASTM A-123 (AASHTO M- 111). Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of ASTM A-82 (AASHTO M-32) and galvanized in accordance with ASTM A-123 (AASHTO M-111).

(i) Leveling Pad: An unreinforced concrete leveling pad shall be constructed as shown in the plans. The concrete shall be Class M concrete conforming to Section 901.

(j) Geotextile Fabric: The fabric shall be in accordance with Section 1019, classes B, C, or D. The fabric shall be resistant to chemical, biological, and insect attack.

(k) Free Draining Aggregate: The free draining aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

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(l) Geomembrane: If required in the plans, a single-layer continuous polymeric sheet shall be placed as indicated in the plans. The geomembrane shall be manufactured from a virgin polymeric resign. The geomembrane shall conform to the following requirements:

Property	Test Method	Minimum Requirements
Thickness, mm (mills)	ASTM D 5199	1.00 (40)
Tensile, kN/m (lb/in.)	ASTM D 882 25 mm (1 in.) strip	12.2 (70)
Tear, N (lb.)	ASTM D 1004 Die C	90 (20)
Puncture, N (lb.)	ASTM D 4833 modified	180 (40)
Impact, J (ft.-lb.)	ASTM D 1424 modified	19 (25)

CONSTRUCTION

(a) Wall Excavation and Foundation Preparation: Wall excavation and foundation preparation shall be in accordance with the special provisions for MSEW Structural Excavation and Backfill.

(b) Leveling Pad Construction: At each MSEW foundation level, a precast reinforced or cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The leveling pad shall be cured a minimum of 12 hours before placement of wall blocks. If the permanent MSEW facing shall be installed in front of a temporary MSEW facing, the leveling pad shall be installed just prior to construction of the permanent MSEW facing.

(c) MSEW System Supplier's Representative: The MSEW system supplier shall provide qualified and experienced advisory personnel at the start of the wall construction and until such time that the engineer feels the DOTD inspectors and the contractor's personnel are adequately acquainted with the MSEW construction procedures and no longer require technical assistance. The representative shall also be available on an as needed basis, as requested by the engineer, during construction of the MSEW structures.

(d) Internal Drainage System: If required in the plans, an internal drainage system shall be installed behind the wall as indicated or as shown on the approved working drawings. Outlet pipes shall be placed at sags in the flow line, at the low end of the collector pipe, and at other locations shown or specified. Location and elevation of the internal drainage system shall be determined by the contractor and submitted to the engineer for approval.

(e) Geotextile Fabric: MSEW with precast concrete panel facings shall have a geotextile fabric covering all joints between panels on the back side of the wall. The geotextile fabric shall have a minimum width of 300 mm (12 inches) and shall overlap adjacent geotextile fabrics a minimum of 100 mm (4 inches). Geotextile fabric shall be adhered to panels by applying

adhesive to the back of the panel on each side of the joint. Adhesive shall not be applied directly on the geotextile fabric or within 50 mm (2 inches) of the panel joint edge.

MSEW with modular concrete block facings and granular reinforced backfill shall have geotextile fabric placed between the block fill and the reinforced backfill. Geotextile fabric will not be required if a stone reinforced backfill is used.

If required in the plans, geotextile fabric shall be placed between the natural ground and the reinforced backfill. The subgrade to receive the geotextile fabric shall be free of loose or extraneous material and sharp objects that may damage the geotextile fabric during installation. The geotextile fabric shall be stretched, aligned, and placed in a wrinkle-free manner with intimate contact with the soil. Adjacent geotextile fabric edges shall be overlapped a minimum of 0.5 m (1.5 feet).

If approved by the engineer, torn or punctured sections of the geotextile fabric may be repaired or replaced. Geotextile fabric damaged during installation by tearing or puncturing shall be cut out and replaced completely or repaired by placing a piece of fabric that is large enough to cover the damaged area and provide a sufficient overlap minimum 0.5 m (1.5 feet) on all sides to secure the damaged geotextile fabric area.

(f) Wall Erection: Precast concrete panels and modular concrete block facings shall be placed so that their final position is vertical or battered as shown on the plans. Precast concrete panels and modular concrete block facings shall be placed in successive horizontal lifts in the sequence directed by the engineer as backfill placement proceeds. The MSEW structure shall be constructed using a predetermined backward batter corresponding to the anticipated outward wall deflection due to the active soil pressures. This backward batter shall be determined by MSEW system supplier and may be adjusted in the field as directed by the engineer during construction.

MSEW with precast concrete panels shall be handled by a lifting device set into the upper edge of the panels or other approved method. The first level of precast concrete panels shall be placed directly on the concrete leveling pad. Horizontal joint material or wooden shims shall not be permitted between the first course of panels and the leveling pad. As backfill material is placed behind a panel, the panel shall be maintained in position by means of temporary wooden wedges or bracing in accordance with the MSEW system supplier's recommendations. The wooden wedges shall be removed as soon as the panel above the wedged panel is completely erected and backfilled. External bracing shall be required for the first lift of precast concrete panels.

(g) Reinforced Backfill Placement: Backfill placement shall closely follow the erection of each lift of facing elements. At each level of soil reinforcement, the backfill material shall be roughly leveled to an elevation approximately 25 mm (1 inch) above the level of the connection at the facing before placing the soil reinforcement. Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials. Any wall materials, which become damaged during backfill placement, shall be removed and replaced at the contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

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The optimum moisture content and maximum dry weight density shall be determined by DOTD TR 418. The gradation and density shall be checked for every 770 cubic meters (1,000 cubic yards) of backfill material or any variation in backfill material as determined by the engineer. Backfill shall be compacted in accordance with Section 203 to 95 percent of the maximum dry density in accordance with DOTD TR 401. Compaction control testing of the reinforced backfill shall be performed with a minimum frequency of one test per every 1.5 m (5 feet) of wall height for every 30 m (100 feet) of wall. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each-layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The maximum lift thickness (loose) will be 200 mm (8 inches) and shall closely follow the MSEW facing erection. The contractor shall decrease this lift thickness if necessary to obtain the specified density. Backfill compaction shall be accomplished without disturbance to or distortion of the reinforcement. A minimum of 150 mm (6 inches) of backfill material shall be maintained at all times between the contractor's equipment and the soil reinforcement or geotextile fabric.

Compaction adjacent to the backside of the wall facing, within a 1 m (3 foot) wide area, shall be achieved by using light mechanical tampers. Sheepsfoot or grid-type rollers shall not be used for compacting backfill within the soil reinforced backfill.

At the end of each day's operations, the contractor shall shape the last level of backfill to permit runoff of rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall reinforcement zone until this zone is protected from infiltration. Any damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill or retained backfill shall be repaired at the contractor's expense.

(h) Soil Reinforcement Placement: The soil reinforcement shall be installed in accordance with the manufacturer's recommendations and these specifications. The soil reinforcement shall be placed within the layers of the compacted backfill material at the locations shown on the plans. The contractor shall only place that amount of soil reinforcement required for immediately pending work to prevent undue damage. Soil reinforcement shall be placed with the strongest direction of soil reinforcement perpendicular to the wall face, unless shown otherwise in the plans. The soil reinforcement shall be connected to the MSEW facing in accordance with the MSEW system supplier's recommendations. The soil reinforcement shall then be laid flat and uniformly tensioned to remove any slack in the connection or soil reinforcement material.

(i) Final Construction Tolerances: The vertical tolerances (plumbness) and horizontal alignment tolerance shall not exceed 20 mm (3/4 inch) when measured along a 3 m (10 feet) straight edge. The vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 6 mm per meter (1/4 inch per 3 feet) of wall height. The tolerances shall be net measurements after allowance is given for the offset batter of the MSEW facing.

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(j) Surcharge: Should the contract indicate an earth surcharge to be placed over the reinforced zone, the surcharge shall be retained by utilizing a temporary wall. The temporary wall may be built with a temporary MSEW or other approved method. The face of the temporary wall shall be placed within 300 mm (1 foot) of the permanent wall face. The top surface of the surcharge shall allow the surface water to drain away from the wall. A plastic membrane shall be placed over the reinforced zone prior to placing the surcharge material. Materials and the placement and removal of the temporary wall shall be included in the cost of the wall unless indicated otherwise on the plans.

(k) Abutment Piling: If abutments supported on piling are to be placed in the reinforced zone, the following requirements and sequence shall be adhered to unless otherwise indicated in the plans.

1. Drive all piles within the reinforced zone prior to installation.
2. Encase each pile in a Smooth Wall or Corrugated Galvanized Steel (SWCGS) pipe of sufficient thickness to prevent buckling or distortion during placement and compaction of wall backfill.
3. Place spacers between the pile and the SWCGS pipe to prevent the pipe from coming into contact with the pile during backfilling of the wall.
4. Extend the SWCGS pipe from the bottom of the backfill to the bottom of the bridge abutment cap.
5. After positioning, seal the top of the SWCGS pipe to prevent debris accumulation during placement of wall backfill, and keep the pipe sealed until filled with granular material.
6. Fill the SWCGS pipe loosely with granular material after completion of wall construction as directed and approved by the engineer.

MEASUREMENT AND PAYMENT

Mechanically Stabilized Earth Walls, complete in place and accepted, will be paid for at the contract unit price bid per square meter (square foot) which includes funishing all materials, labor, equipment, and other incidentals required to complete this item of work. Payment will include, but shall not be limited to, the following items: precast concrete panels or modular concrete blocks, temporary MSEW facing and facing aggregate, galvanized steel reinforcing and tie strips or galvanized steel mesh and mesh connectors or geosynthetic reinforcement, geotextile fabric, panel coping, block coping or cap blocks, level up concrete, leveling pad, perforated pipe, drain pipe, temporary surcharge wall, and special backfill material requirements.

Excavation below the original ground line and subsequent backfill to the original ground line required for the construction of the MSEW structure will be paid for in accordance with the special provisions for MSEW Structural Excavation and Backfill.

Embankment or reinforced backfill material placed above the original ground line will be measured and paid for under Section 203. Additional costs associated with its special material requirements will be included in the special provision for Mechanically Stabilized Earth Wall (MSEW).

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When changes in the work are ordered by the engineer, which vary the square meter (square foot) wall quantity shown on the plans, the additional MSEW quantity shall be paid for at the contract unit price.

Payment will be made under:

Item S-000(A), Mechanically Stabilized Earth Wall *(MSEW system supplier),* per square meter (square foot)

APPENDIX F

SPECIAL PROVISIONS

TEMPORARY MECHANICALLY STABILIZED EARTH WALL (MSEW)

SAMPLE SPECIFICATION

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SPECIAL PROVISIONS
(Temporary MSEW)

ITEM S-000, TEMPORARY MECHANICALLY STABILIZED EARTH WALL (MSEW)

MSEW SUBMITTALS

MSEW DESIGN

- **(a)** Design Scope
- **(b)** General Design Methodology
- **(c)** Design Calculations

WORKING DRAWINGS

- **(a)** General
- **(b)** Top of Wall
- **(c)** MSEW Base Elevation
- **(d)** Earth Surcharges

MSEW MATERIALS

- **(a)** General
- **(b)** Temporary MSEW Facing
  - **(1)** Welded Wire Mesh Facing
  - **(2)** Temporary Facing Aggregate
- **(c)** Inextensible Soil Reinforcement
  - **(1)** Reinforcing Steel Strips
  - **(2)** Reinforcing Welded Wire Mesh
  - **(3)** Galvanization Damage
- **(d)** Extensible Soil Reinforcement
  - **(1)** Geosynthetic Soil Reinforcement
  - **(2)** Delivery, Storage, and Handling of Geosynthetic Materials
  - **(3)** Quality Assurance Testing
- **(e)** MSEW Certification Package
- **(f)** Reinforced Backfill Material
  - **(1)** Granular Backfill
  - **(2)** Stone Backfill
  - **(3)** Soil Property Requirements For All Backfill
  - **(4)** Testing Frequency
- **(g)** Geotextile Fabric
- **(h)** Free Draining Aggregate
- **(i)** Geomembrane

CONSTRUCTION

- **(a)** Wall Excavation and Foundation Preparation

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(b) MSEW System Supplier's Representative
(c) Geotextile Fabric
(d) Wall Erection
(e) Reinforced Backfill Placement
(f) Soil Reinforcement Placement
(g) Final Construction Tolerances
(h) Surcharge
(i) Abutment Piling

MEASUREMENT AND PAYMENT

SAMPLE SPECIFICATION

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ITEM S-000, TEMPORARY MECHANICALLY STABILIZED EARTH WALL (MSEW): This item consists of designing, furnishing, and constructing a temporary Mechanically Stabilized Earth Wall (MSEW) with a welded wire facing in accordance with these specifications and MSEW system supplier's recommendations, and in conformance with the lines, grades, design, and dimensions shown on the plans or established by the engineer. Design details for these MSEW structures such as specified geogrid, strip, or mesh; welded wire facing dimensions; loading conditions; leveling pad dimensions; temporary surcharge retaining wall; and details for appurtenances shall be as shown on the plans or as specified herein.

MSEW SUBMITTALS

The contractor shall submit design calculations and working drawings (shop drawings) to the Bridge Design Engineer in accordance with the policies and procedures that are detailed in subsection 801.03 and the requirements provided herein. The contractor shall allow 45 calendar days from the day the design calculations and the working drawings are received by the engineer for review and approval. Fabrication or any construction shall not begin prior to written approval of the design and working drawings. All plans and calculations shall bear the legible seal, date, and signature of the responsible Professional Civil Engineer registered in the State of Louisiana with the following Statement: ***"Certified with respect to structural adequacy and stability in accordance with LA DOTD requirements and procedures ".***

When MSEW Certification Packages are used to document the ultimate and allowable tensile load of extensible (geosynthetic) soil reinforcement and soil reinforcement pullout coefficients (F^*, α), the contractor shall submit the Certification package to the Pavement and Geotechnical Design Engineer for approval. The contractor shall allow 20 calendar days for review and approval of the Certification package. The MSEW soil reinforcement and welded wire facings shall not be delivered to the site without prior written approval of the MSEW system supplier's Certification package.

MSEW DESIGN

(a) Design Scope: The MSEW structures shall be considered gravity walls and shall be designed for external and internal stability of the reinforced soil mass. The Department will be responsible for the external stability, which shall consist of checking global stability for deep-seated failures, sliding stability, overturning, settlement analysis, and bearing of the reinforced soil mass. The external stability of the MSEW structure, with appropriate safety factors, is satisfied with the minimum base width required, BReq, that is specified in the plans.

The contractor's MSEW system supplier shall be responsible for the internal stability design of the permanent MSEW structure. The supplier's design shall consist of determining the required soil reinforcement length and strength, facing/soil reinforcement connection strength, and facing stability in accordance with the plans and this special provision. The supplier's design shall also specify the minimum required wall face batter to limit the amount of horizontal movements resulting from the outward rotation of the wall as a result of the development of internal equilibrium between the loads applied to the wall and the internal structure of the wall.

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The supplier shall be responsible for the design of any temporary MSEW surcharge retaining walls located above the permanent MSEW structure, or other temporary construction systems that are required to build the temporary MSEW structure.

(b) General Design Methodology: The design of the temporary MSEW and temporary construction systems shall be in accordance with the *Department's Geotechnical Engineering Technical Guide No. 8, Mechanically Stabilized Earth Wall (MSEW) Design Guide,* and the 1998 interim or more current edition of the AASHTO "Standard Specifications for Highway Bridges." The Department will not accept designs based on methodology other than required by these specifications.

(c) Design Calculations: The contractor shall supply the Department with a complete set of the MSEW supplier's design calculations in accordance with this specification. Computer generated designs used by the supplier shall be reviewed and approved by the Department. Verification that the computer program's design methodology meets the requirements provided herein, and the accuracy of the computer generated solution, shall be made by having the supplier submit a copy of the computer program and a complete, legible, hand calculation check for the most critical geometry and loading condition that will govern the design of the MSEW structure. The determination of all loading conditions shall be fully documented with all design calculations and assumptions. Submitted calculations (including computer runs) shall include all load cases that exist at final completion and during construction for any required surcharges, hydraulic conditions, live loads, and loading combinations. A summary of the design computations indicating geometry, loadings, and analysis results shall be furnished with the design calculations.

WORKING DRAWINGS

(a) General: The drawings shall include the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines shown in the contract plans. The vertical bearing pressure exerted by the MSEW structure, relative to changes in wall height and soil reinforcement length shall be shown clearly on the plans. The working drawings shall also reflect all information needed to fabricate and erect the walls including:

1. Existing ground elevations that have been verified by the contractor for each location.
2. MSEW profile elevation showing MSEW base elevations, maximum bearing loads, top of wall elevation, etc.;
3. Details of temporary wall facing;
4. Details of wall batter;
5. Shape and dimensions of MSEW facings;
6. The number, size, type, and details of the soil reinforcing elements;
7. Details of facing/reinforcement connections;
8. Details showing location and installation of geotextile fabric;
9. Details at miscellaneous obstructions (i.e. utility conduits) located below the ground surface;
10. Details at bridge foundation obstructions;

11. Dimensions of structural backfill required;
12. Any additional details pertaining to internal drainage or other construction items, as required by the contract plans.

(b) Top of Wall: Written approval will be required to lower the top of wall elevations shown on the plans.

(c) MSEW Base Elevation: Written approval will be required to raise the MSEW base elevations shown on the plans. The MSEW base embedment may be increased to a maximum of 500 mm (20 inches) without written approval. The MSEW base elevations shall be such as to allow for transverse and longitudinal drainage structures shown on the plans.

(d) Earth Surcharges: Should the plans indicate an earth surcharge to be placed over the reinforced zone, the surcharge may be retained by extending the temporary MSEW structure to the top of the surcharge.

MSEW MATERIALS

(a) General: The contractor shall make arrangements to purchase or manufacture all applicable materials such as the facing elements, soil reinforcements, geotextile fabric, facing aggregate, reinforced backfill materials, internal drainage system (if required), and all other necessary components. Written approval from the engineer shall be required to use materials or sources of materials not conforming to the specifications nor listed in the contract documents.

(b) Temporary MSEW Facings:

(1) Welded Wire Mesh Facing: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-55). Galvanization, if required, shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M- 111).

(2) Temporary Facing Aggregate: The temporary facing aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

(c) Inextensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Reinforcing Steel Strips: Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to ASTM A 572 Grade 65 (AASHTO M-223) or equal. Galvanization, if required, shall conform to the minimum requirements or ASTM A-123 (AASHTO M-111).

(2) Reinforcing Welded Wire Mesh: Reinforcing mesh shall be shop-fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A-82 (AASHTO M-55). Galvanization, if required, shall be applied after the mesh is fabricated and shall conform to the minimum requirements of ASTM A-123 (AASHTO M-111).

(3) Galvanization Damage: Any damage done to the galvanization prior to the soil reinforcement installation shall be repaired with a cold galvanizing repair compound

conforming to Subsection 1008.06 to provide a galvanized coating comparable to that provided by ASTM A 123 (AASHTO M- 111).

(d) Extensible Soil Reinforcement: All reinforcing shall conform to the required shape and dimensions and shall be free of defects that may impair their strength and durability. Reinforcing will be sampled and tested by the Department before fabrication or erection of the MSEW structure.

(1) Geosynthetic Soil Reinforcement: Geosynthetic design requirements shall be as shown in the plans and specified in the working drawings. Geotextile reinforcement shall be a woven geotextile consisting only of long chain polymeric filaments or yarns formed into a stable network. Geogrid reinforcements shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil. The structure of geosynthetic reinforcements shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.

(2) Delivery, Storage, and Handling of Geosynthetic Materials: The contractor shall check the geosynthetic soil reinforcement upon delivery to ensure that the proper material has been received. Geosynthetic rolls shall be labeled per ASTM D 4837, Guide for Identification, Storage, and Handling of Geosynthetic Rolls. During all periods of shipment-and storage, the geosynthetic materials shall be protected from temperatures greater than 60°C (140 degrees Fahrenheit), mud, dirt, dust, and debris. The manufacturer's recommendations regarding protection from direct sunlight should be followed. At the time of installation, the geosynthetic materials shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. The contractor, at no additional cost to the Department, shall replace any geotextile fabric or geosynthetic reinforcement damaged during storage or installation.

(3) Quality Assurance Testing: All geosynthetic soil reinforcements, regardless of prior approval, shall be sampled in accordance with the Materials Sampling Manual and tested by the Department for quality assurance. The ultimate tensile strength must meet the strength required to achieve the specified T_a or T_{ac} based on the reduction factors and the required factor of safety from an approved manufacturer's Certification Package. If the type of geosynthetic soil reinforcement selected by the contractor requires special clamps or testing procedures other than those normally used by the Department, the engineer may require the contractor to supply the quality assurance testing as required by the Department to determine the ultimate tensile strength at no additional cost to DOTD. The Department shall supply the test samples collected to a DOTD approved independent laboratory for quality assurance testing. No geosynthetic soil reinforcement shall be used to construct the MSEW structure until the results of the quality assurance testing indicate that the soil reinforcement delivered to the site is in conformance with these specifications and the approved manufacturer's Certification Package.

(e) MSEW Certification Package: The contractor shall submit a Certification Package prepared by the MSEW supplier or MSEW component manufacturer. The MSEW

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Certification Package shall include a Certificate of Compliance that certifies the following (as applicable to the MSEW system):

1. The ultimate tensile strength, T_{ULT}, (MARV) for extensible soil reinforcements (geosynthetics).
2. The allowable tensile load, T_a, multiplied by the reinforcement coverage ratio, R_c, meets or exceeds the MSE block wall's maximum applied tensile load, T_{max}.
3. The geosynthetic's pullout coefficients (**F***, α) meet or exceed the MSEW's required design pullout coefficients.

The certified values shall be documented as indicated in the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide.* In case of a dispute over the validity of values, testing shall be performed by DOTD. For tests unable to be performed by DOTD, the engineer will require the contractor to supply test data from a DOTD approved independent laboratory to support the certified values. These additional tests shall be performed at no additional cost to the Department. If in the opinion of the engineer, the required documentation is not provided for individual reduction factors (RF) or pullout coefficients (F*, α), default values for these design parameters shall be used in accordance with the Geotechnical Engineering Design Guide No. 8, *Mechanically Stabilized Earth Wall (MSEW) Design Guide.* If the MSEW supplier chooses to use default values, the Certificate of Compliance shall indicate this.

(f) Reinforced Backfill Material: The reinforced backfill material shall be a select granular material unless a stone backfill is specified in the plans. The granular and stone backfills shall conform to Subsection 1003.01 with the following engineering properties and material requirements.

(1) Granular Backfill: The internal friction angle (φ) for the reinforced granular backfill shall not be less than 30 degrees. The granular backfill material shall have the gradation shown in Table 2.

Table 2 - Reinforced Granular Backfill Gradation

Sieve Size	Percent Passing
19 mm (¾")	100
4750 µm (No. 4)	20 - 100
2000 µm (No. 10)	15 - 85
425 µm (No. 40)	10 - 35
150 µm (No. 100)	0 - 10
75 µm (No. 200)	0 - 5

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(2) Stone Backfill: The internal friction angle (φ) for the reinforced stone backfill shall not be less than 34 degrees. The stone backfill material shall have the gradation shown in Table 3.

Table 3 - Reinforced Stone Backfill Gradation

Sieve Size	Percent Passing
25 mm (1")	100
19 mm (¾")	90 - 100
9.5 mm (⅜")	20 - 55
4750 µm (No. 4)	0 - 10
2360 µm (No. 8)	0 - 5

(3) Soil Property Requirements For All Backfill: All reinforced backfill and temporary facing aggregate shall have the following soil properties:

1. pH values shall range between 4.5 and 9.0 (TR 430).

2. Organic content shall not exceed 0.5 percent (weight of organic material to weight of total sample as determined by TR 413).

3. Internal friction angle shall not be less than the values specified above as determined by the standard direct shear test, AASHTO T-236 or the triaxial test, AASHTO T-234. Material test samples shall be compacted to 95% of maximum density at optimum moisture content as determined by DOTD TR 418.

(4) Testing Frequency: All soil property requirements shall be tested during initial source approval or if a change in source is requested. Reinforced backfill material shall be sampled once every 770 cubic meters (1,000 cubic yards) and tested for gradation and pH. Reinforced backfill material shall be sampled once every 3800 cubic meters (5,000 cubic yards) and tested for internal friction angle and organic content. A variation in testing frequency may be required if a variation in material gradation or composition is observed.

(g) Geotextile Fabric: The fabric shall be in accordance with Section 1019, classes B, C, or D. The fabric shall be resistant to chemical, biological, and insect attack.

(h) Free Draining Aggregate: The free draining aggregate shall be crushed stone or crushed gravel with the same gradation as the stone backfill referenced in the reinforced backfill materials section of this special provision.

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(i) Geomembrane: If required in the plans, a single-layer continuous polymeric sheet shall be placed as indicated in the plans. The geomembrane shall be manufactured from a virgin polymeric resign. The geomembrane shall conform to the following requirements:

Property	Test Method	Minimum Requirements
Thickness, mm (mills)	ASTM D 5199	1.00 (40)
Tensile, kN/m (lb/in.)	ASTM D 882 25 mm (1 in.) strip	12.2 (70)
Tear, N (lb.)	ASTM D 1004 Die C	90 (20)
Puncture, N (lb.)	ASTM D 4833 modified	180 (40)
Impact, J (ft.-lb.)	ASTM D 1424 modified	19 (25)

CONSTRUCTION

(a) Wall Excavation and Foundation Preparation: MSEW excavation shall be in accordance with the requirements of Section 802.

The foundation for the temporary MSEW structure shall be graded level for a width equal to or exceeding the length of the soil reinforcements plus 0.3 m (1 foot) or as shown in the plans. Prior to the MSEW construction, the foundation shall be compacted with a smooth vibratory wheel roller weighing a minimum of 7.2 Mg (8 tons) for at least five passes or as directed by the engineer. Any foundation soils found to be unstable by the engineer shall be removed and replaced with backfill material and compacted to 95 percent of the maximum density as determined by DOTD TR 418.

(b) MSEW System Supplier's Representative: The MSEW system supplier shall provide qualified and experienced advisory personnel at the start of the wall construction and until such time that the engineer feels the DOTD inspectors and the contractor's personnel are adequately acquainted with the MSEW construction procedures and no longer require technical assistance. The representative shall also be available on an as needed basis, as requested by the engineer, during construction of the MSEW structures.

(c)Geotextile Fabric: MSEW with welded wire mesh facings shall have the free draining aggregate wrapped with a geotextile fabric as shown in the plans. The geotextile fabric shall overlap adjacent geotextile fabrics a minimum of 150 mm (6 inches).

If required in the plans, geotextile fabric shall be placed between the natural ground and the reinforced backfill. The subgrade to receive the geotextile fabric shall be free of loose or extraneous material and sharp objects that may damage the geotextile fabric during installation. The geotextile fabric shall be stretched, aligned, and placed in a wrinkle-free

manner with intimate contact with the soil. Adjacent geotextile fabric edges shall be overlapped a minimum of 0.5 m (1.5 feet).

If approved by the engineer, torn or punctured sections of the geotextile fabric may be repaired or replaced. Geotextile fabric damaged during installation by tearing or puncturing shall be cut out and replaced completely or repaired by placing a piece of fabric that is large enough to cover the damaged area and provide a sufficient overlap minimum 0.5 m (1.5 feet) on all sides to secure the damaged geotextile fabric area.

(d) Wall Erection: The welded wire mesh facing and facing aggregate shall be placed so that their final position is vertical or battered as shown on the plans. The welded wire mesh facing and facing aggregate shall be placed in successive horizontal lifts in the sequence as directed by the engineer as backfill placement proceeds. The MSEW structure shall be constructed using a predetermined backward batter corresponding to the anticipated outward wall deflection due to the active soil pressures. This backward batter shall be determined by the MSEW supplier and may be adjusted in the field as directed by the engineer during construction.

(e) Reinforced Backfill Placement: Backfill placement shall closely follow the erection of each lift of facing elements. At each level of soil reinforcement, the backfill material shall be roughly leveled to an elevation approximately 25 mm (1 inch) above the level of the connection at the facing before placing the soil reinforcement. Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials. Any wall materials, which become damaged during backfill placement, shall be removed and replaced at the contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

The optimum moisture content and maximum dry weight density shall be determined by DOTD TR 418. Backfill shall be compacted in accordance with Section 203 to 95 percent of the maximum dry density in accordance with DOTD TR 401. Compaction control testing of the reinforced backfill shall be performed with a minimum frequency of one test per every 1.5 m (5 feet) of wall height for every 3 0 m (100 feet) of wall. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The maximum lift thickness (loose) will be 200 mm (8 inches) and shall closely follow the MSEW facing erection. The contractor shall decrease this lift thickness if necessary to obtain the specified density. Backfill compaction shall be accomplished without disturbance to or distortion of the reinforcement. A minimum of 150 mm (6 inches) of backfill material shall be maintained at all times between the contractor's equipment and the soil reinforcement or geotextile fabric, if required. Compaction adjacent to the backside of the wall facing, within a 1 m (3 foot) wide area, shall be achieved by using light mechanical tampers. Sheepsfoot or grid-type rollers shall not be used for compacting backfill within the soil reinforced backfill.

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At the end of each day's operations, the contractor shall shape the last level of backfill to permit runoff of rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall reinforcement zone until this zone is protected from infiltration. Any damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill or retained backfill shall be repaired at the contractor's expense.

(f) Soil Reinforcement Placement: The soil reinforcement shall be installed in accordance with the manufacturer's recommendations and these specifications. The soil reinforcement shall be placed within the layers of the compacted backfill material at the locations shown on the plans. The contractor shall only place that amount of soil reinforcement required for immediately pending work to prevent undue damage. Soil reinforcement shall be placed with the strongest direction of soil reinforcement perpendicular to the wall face, unless shown otherwise in the plans. The soil reinforcement shall be connected to the MSEW facing in accordance with the MSEW system supplier's recommendations. The soil reinforcement shall then be laid flat and uniformly tensioned to remove any slack in the connection or soil reinforcement material.

(g) Final Construction Tolerances: The vertical tolerances (plumbness) and horizontal alignment tolerance shall not exceed 25 mm (1 inch) when measured along a 3 m (10 feet) straight edge. The vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 15 mm per meter (1/2 inch per 3 feet) of wall height. The tolerances shall be net measurements after allowance is given for the offset batter of the MSEW facing.

(h) Surcharge: Should the contract indicate an earth surcharge to be placed over the reinforced zone, the surcharge shall be retained by utilizing a temporary wall. The temporary wall may be built by extending the temporary MSEW structure to the required surcharge height or other approved method. The top surface of the surcharge shall allow the surface water to drain away from the wall. A plastic membrane shall be placed over the reinforced zone prior to placing the surcharge material. Materials and the placement and removal of the temporary wall shall be included in the cost of the wall unless indicated otherwise on the plans.

(i) Abutment Piling: If abutments supported on piling are to be placed in the reinforced zone, the following requirements and sequence shall be adhered to unless otherwise indicated in the plans.

1. Drive all piles within the reinforced zone prior to installation.
2. Encase each pile in a Smooth Wall or Corrugated Galvanized Steel (SWCGS) pipe of sufficient thickness to prevent buckling or distortion during placement and compaction of wall backfill. Payment to be included in the cost of the wall.
3. Place spacers between the pile and the SWCGS pipe to prevent the pipe from coming in contact with the pile during backfilling of the wall.
4. Extend the SWCGS pipe from the bottom of the backfill to the bottom of the bridge abutment cap.

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5. After positioning, seal the top of the SWCGS pipe to prevent debris accumulation during placement of wall backfill, and keep the pipe sealed until filled with granular material.
6. Fill the SWCGS pipe loosely with granular material after completion of wall construction as directed and approved by the engineer.

MEASUREMENT AND PAYMENT

Mechanically Stabilized Earth Walls, complete in place and accepted, will be paid for at the contract lump sum price. This item includes furnishing all materials, labor, equipment, and other incidentals required to complete this item of work. Payment will include, but shall not be limited to, welded wire facing, galvanized steel reinforcing or geosynthetic reinforcement, geotextile fabric, temporary surcharge wall, and special backfill material requirements.

Excavation below the original ground line and subsequent backfill to the original ground line required for the construction of the temporary MSEW structure will be included in this item.

Embankment or reinforced backfill material placed above the original ground line will be measured and paid for under Section 203. Additional costs associated with its special material requirements will be included in the Temporary Mechanically Stabilized Earth Wall item.

Payment will be made under:

Item S-000, Temporary Mechanically Stabilized Earth Wall, per lump sum

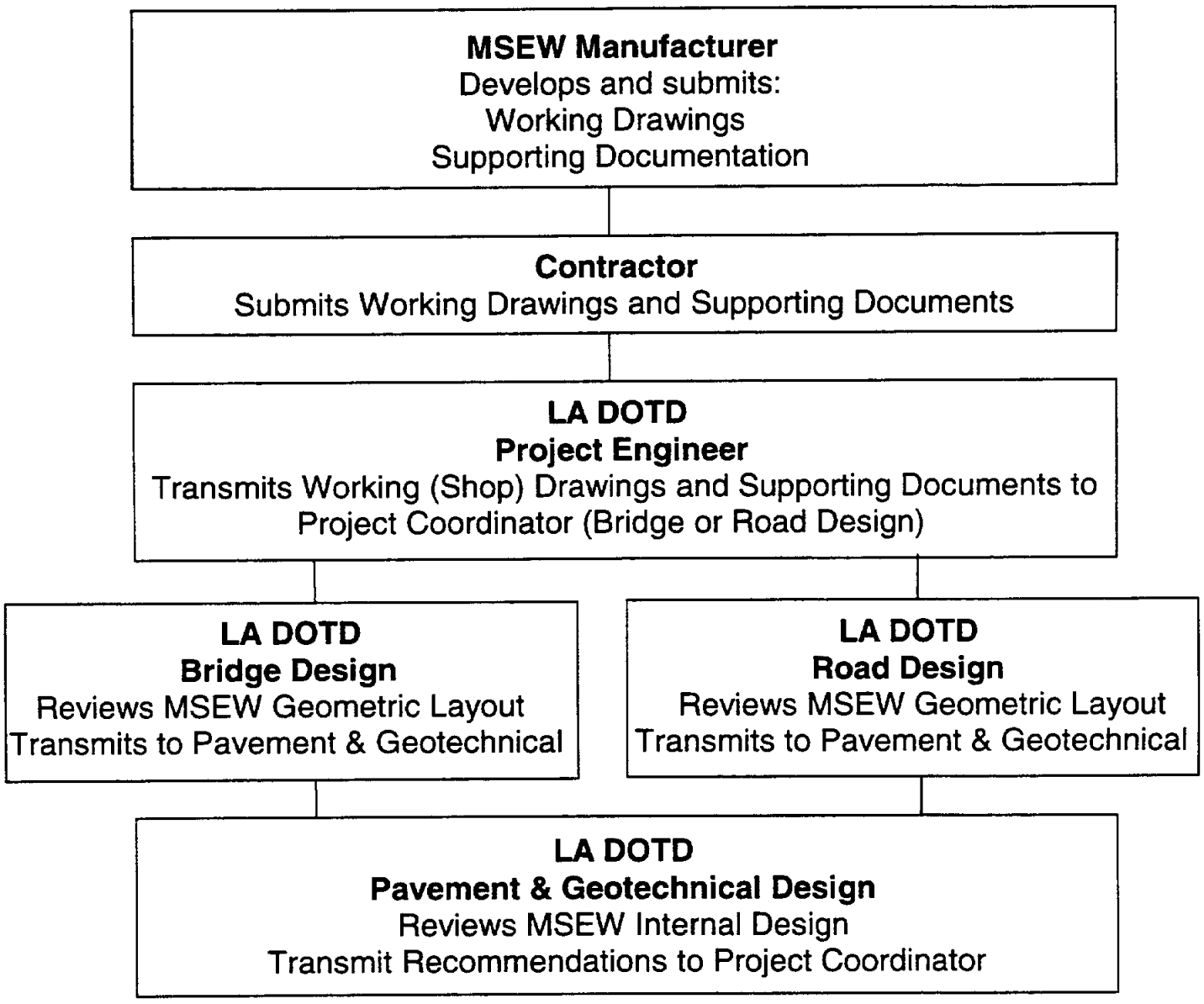
APPENDIX G

MECHANICALLY STABILIZED EARTH WALL (MSEW) REVIEW / APPROVAL

Louisiana Department of Transportation and Development
Pavement & Geotechnical Design

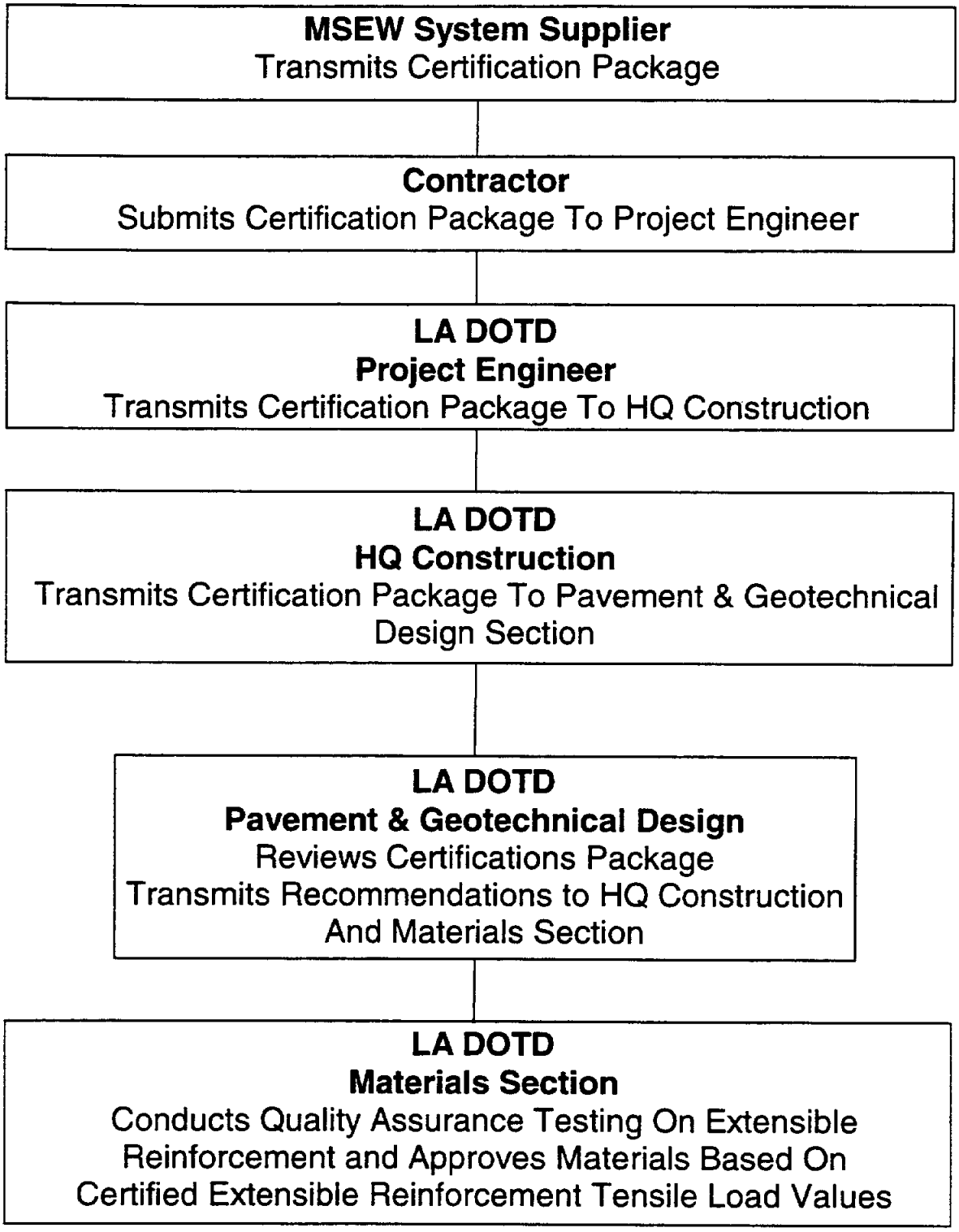
GEDG NO. 8 (10/01/1999)

MSEW Review & Approval
Working (Shop) Drawings And Supporting Documentation



MSEW Review & Approval

MSEW Certification Package



MSEW WORKING DRAWINGS/FINAL DESIGN DRAWINGS REVIEW CHECK LIST

General: The working drawings should be checked for following general items:

1. Have existing ground elevations and utility locations been verified by the Department or Contractor for each location?
2. Does the MSEW profile show:
   - ☐ beginning and end of wall stations
   - ☐ offsets and stations
   - ☐ leveling pad elevations
   - ☐ maximum bearing loads
   - ☐ top of wall elevation, etc.;
3. Have slip joints been provided to prevent stresses due to anticipated settlement shown on the plans?
4. Do joint details indicate
   - ☐ type
   - ☐ size
   - ☐ manufacturer
5. Is wall batter shown?
6. Is the shape and dimensions of MSEW facings shown?
7. Do soil reinforcement details indicate:
   - ☐ length
   - ☐ number
   - ☐ size
   - ☐ type
   - ☐ location & elevation
8. Is there a facing/reinforcement connection detail shown?
9. Are the geotextile fabric locations shown?
10. Are the leveling pad dimensions shown?
11. Are details at miscellaneous obstructions (i.e. utilities) below ground elevation shown?
12. Are details at bridge foundation obstructions shown?
13. Are the structural backfill dimensions shown?
14. Are special details required by the contract plans shown for:
    - ☐ coping
    - ☐ railing
    - ☐ temporary facing
    - ☐ internal drainage
    - ☐ subsurface or electrical conduit

Top of Wall:

- ❑ Written approval will be required to lower the top of wall elevations shown on the plans.
- ❑ The top of wall elevation for MSEW with modular concrete block facing may be increased to a maximum of 205 mm (8 inches) without written approval.
- ❑ The top of wall elevations shall be such as to allow for proper interfacing with barrier copings, surface ditches, bridge abutments, etc. as shown in the plans.

Leveling Pad:

- ❑ Written approval will be required to raise the minimum leveling pad elevations shown on the plans.
- ❑ Leveling pad embedment depths may be increased to a maximum of 0.5 m (20 inches) without written approval.
- ❑ The leveling pad elevations shall be such as to allow for transverse and longitudinal drainage structures shown on the plans.

Special Wall Interface Details: Are wall interface details with other walls that will be constructed before, on, or after this contract shown? The wall ends shall not be placed over pile supported footings. Do special wall interface details show:

- ❑ special facing element
- ❑ wing wall slip joint
- ❑ end this wall(s)
- ❑ compaction requirements

Special Wall Interface Details For Adjacent MSEW With Precast Concrete Panel Facings: Are the columns of panels that are adjacent to the interface location on this project modified in order to phase out the joint line produced under normal conditions to a joint that is vertical at the interface? Are the panels modified as follows:

- ❑ The modified panels shall be 50 mm (2 inches) thicker than the normal panel.
- ❑ The side of the panel that coincides with the interface line shall be keyed in order to mate with the adjacent panel on the adjacent project.
- ❑ The horizontal joint lines for the adjacent panels on either side of the interface shall be offset vertically by ½ panel.

Earth Surcharges: Are earth surcharges over the reinforced zone shown? Is the method of retaining the surcharge shown? If a temporary MSEW structure is used to retain the surcharge, are sufficient construction details provided?

Precast Concrete Panel Facing Layout: Are numbered panel layout drawings for fabrication and erection purposes shown for precast concrete panel facings?